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SPECTRANS-2
A MODIFIED COMPUTER CODE FOR STANDARDIZING NEUTRON SPECTRA

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A MODIFIED COMPUTER CODE FOR STANDARDIZING NEUTRON SPECTRA

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ABSTRACT

The SPECTRANS-2 code is written for comparison and evaluation of neutron spectra computed or measured by different techniques. The code calculates the spectra in 48 predetermined energy intervals indepedently from the original interval distribution of the input spectra. The code computers Kerma and Dose-equivalent spectra as well as dose fractions and average energies from the standardized neutron spectra. It can interpolate the leakage spectra for one intermediate thickness between two known thicknesses of a shielding material as well as the reading of any kind of dosimeters. The calculated spectra are written on a library tape and draw by an off-line plotter.

KIVONAT

A SPECTRANS-2 program lehetővé teszi különböző módon számitott és mért neutron spektrumok összehasonlitását és kiértékelését azáltal, hogy függvényinterpolációk segitségével a spektrumokat egységesen 48 energiaintervallumban adja meg. A program standardizált neutronspektrumokból kerma- és dózisekvivalens spektrumokat, valamint dózishányadokat és átlagenergiát számit. Interpoláció segitségével meghatározza egy kivánt vastagságu védőrétegen áthaladt neutronok spektrumát, ezenkivül felhasználható doziméterek jelzésének számitására. A spektrumokat könyvtárszalagon rögziti és egy plotter segitségével kirajzolja.

РЕЗЮМЕ

Программа SPECTRANS-2, производящая методом интерполяции стандартное представление нейтронных спектров в 48 интервалах энергии, дает возможность сравнения и оценки спектров, вычисленных и измеренных разными методами. Из стандартизованных нейтронных спектров программа вычисляет спектры керма и бэр, а также процент дозы и среднюю энергию. Программа, с помощью интерполяции, определяет спектр нейтронов, кроме того, можно использовать расчеты, произведенные по показаниям дозиметров. Спектры записываются самописцем и на магнитную ленту.

I. Introduction

Neutron spectra calculated or measured by the different methods described in the literature can often be compared to each other only with difficulty and used for evaluation of dosimeters, because they refer to different values; for instance $\varphi(E)$ or $\varphi(u)$ etc.

The SPECTRANS-2 code, designed to simplify work with the spectra, makes a neutron spectrum library by standardizing neutron spectra from input spectra of different forms. The code also calculates kerma and dose-equivalent spectra as well as dose fractions and average energy. The program can compute the leakage spectra for a given intermediate thickness between two known thicknesses of a shielding material /if these spectra are on the library tape/ on the assumption that the attenuation is exponential in the whole energy range. The reading of any kind of dosimeters can be calculated reading both the standardized response of the dosimeter and the leakage spectrum from the library tape.

After each computation the spectra are drawn by an off-line plotter. The original and standardized spectra as well as the calculated data are available from the spectrum library.

II. Description of standardizing

The first task is to make a standardized spectrum from the input spectrum. This is done by Lagrange and linear interpolation. In each standardized energy interval the program determines both interpolations, compares the results, and the result that approximates the input function better in the given interval is used for the further calculation.

Lagrange interpolation

The function which is to be approximated, denoted by f/x/, is defined in the interval $[x_1 ; x_n]$. If $x_1, \ldots, x_n$ are different optional base points then the Lagrange polynomial is

$$P/x/ = \sum_{k=1}^{n} f/x_k/ \cdot \prod_{\substack{i=1 \\ i \neq k}}^{n} \frac{x - x_i}{x_k - x_i} \qquad 1/$$

Generally it is not necessary to know the P/x/ polynomial in its explicit form $a_o + a_1x + a_2x + \ldots + a_{n-1}x^{n-1}$; the knowledge of its values at m discrete points $(\xi_1, \xi_2, \ldots \xi_m)$ is enough. An algorithm for computer calculation of the P/x/ values /here called A/ is given in [1].

In Eq. 1/ P/x/ is a Lagrange polynomial of degree /n-1/ and has /n-2/ extremes. The positions of these extremes may all be inside the $[x_1 ; x_n]$ interval. In that case, if f/x/ has less than /n-2/ extremes the interpolating polynomial is not a good approximation to the original function but oscillates. This happens, often, especially when f/x/ is monotonous in a large interval within $[x_1 ; x_n]$. The oscillation increases when the value of $|\max f/x/ - \min f/x/|$ in an energy interval $[x_1 ; x_n]$ - or the energy interval itself - is large. Sometimes the value of P/x/ will be less than 0, despite the fact that $x_1 > 0$ and $f/x/ > 0$ in the whole $\left[x_1 \,;\, x_n\right]$ interval.

<u>Linear interpolation</u>

$$L/x/ = f/x_i/ + \frac{\left(f/x_k/ - f/x_i/\right) \cdot /x - x_i/}{x_k - x_i} \qquad 2/$$

where $\xrightarrow{\quad x_i \quad x \quad x_k \quad}$

This interpolation results in large error when an extreme lies between x_i and x_k, but gives a good approximation if the function is monotonous and changing only slowly.

<u>The standardizing procedure</u>

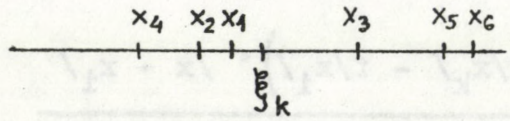
To avoid the difficulties mentioned above the following procedure is utilized.

Let f/x/ represent an input spectrum φ /u/. $f/x/ > 0$ for each x owing to its meaning. If the input spectrum is φ /E/ or it is given in a different manner, then it is converted by the code to φ/u/. This results in the value of $\left| \max f/x/ - \min f/x/ \right|$ being small, and $x_i = \log_{10} E_i$ is used instead of E_i to decrease the length of the $\left[x_1 \,;\, x_n\right]$ interval.

The standardized output spectrum φ/u/ is denoted by g/ξ/. This is a combination of three different approximate functions:

a/ $g_1(\xi)$ computed by algorithm A using six base points. These points $/x_1, x_2, x_3, x_4, x_5, x_6/$ are chosen on the basis of the conditions:

$$\left|x_{i+1} - \xi_k\right| \geq \left|\xi_k - x_i\right| \qquad i = 1,2,3,4,5$$

e.g. 

b/ $g_2(\xi)$ calculated also by algorithm A but for four base points.

c/ $g_3(\xi)$ computed by linear interpolation.

The combination is carried out in two steps.

1/ $g(\xi)$ must be greater than 0 in the whole $[x_1\ , x_n]$ interval. First of all $g_1(\xi)$, $g_2(\xi)$, $g_3(\xi)$ must be greater than 0. It is obvious that values of $g_3(\xi)$ are greater than zero /because of f/x/ > 0/.

The code tests values of $g_2(\xi)$ in each point step by step if some of the values is less than 0, then it will be replaced with value of $g_3(\xi)$, /e.g. $g_2(\xi_{10}) = g_3(\xi_{10})$/ the negative value is omitted. Similarly if values of $g_1(\xi)$ are less than 0, then the code replaces values of $g_1(\xi)$ with values of $g_2(\xi)$.

Consequently $g_1(\xi)$, $g_2(\xi)$ and $g_3(\xi)$ will be greater than 0 in the whole $[x_1\ , x_n]$ interval. In the following step these modified functions are used.

2/ The number of neutrons calculated from f/x/ and $g(\xi)$ must be equal to each other in each subinterval and in the whole interval, too. Therefore value of $g(\xi_\alpha)$

/ α increases from 1 until m/ is tested for each α.

Let us introduce the following expressions

$S_F = \sum_{i=1}^{k-1} f(x_i)(x_{i+1} - x_i)$ which gives the number of neutrons in $[x_1 , x_k]$ interval /see Fig. 1/ and

$S_G = \sum_{\ell=1}^{j} g(\xi_\ell)(\xi_{\ell+1} - \xi_\ell)$ which gives the number of neutrons in $[\xi_1 , \xi_{j+1}]$ interval.

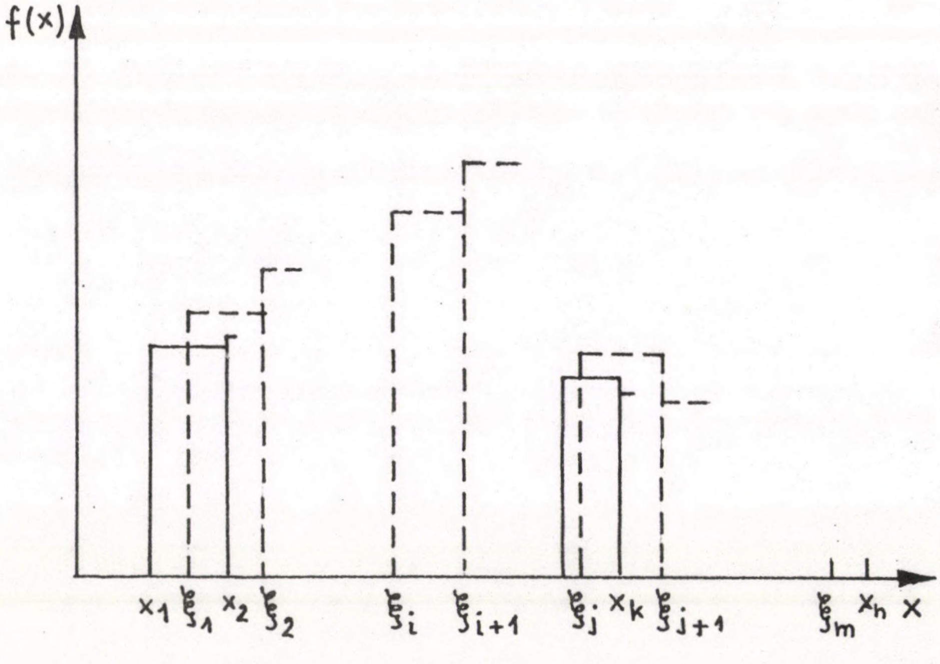


Fig. 1

j and k are calculated from α :

let x_k be the nearest to ξ_j and $x_k > \xi_j$ as well as

if $0 < \alpha < 4$ then j=4

if $4 \leq \alpha$ then j=i+1 and

if α =m then j=m

To reach the best approximation of f/x/ the deviation between S_F and S_G must be small, therefore that value is chosen for $g(\xi_\alpha)$ from among values of $g_1(\xi_\alpha)$, $g_2(\xi_\alpha)$ or $g_3(\xi_\alpha)$ with that the value of $|S_F - S_G|$ will be the smallest.

III. Users' manual

The work name of the program in the CRIP is DPSC.

Program language: ICL-1900 FORTRAN

/This version of FORTRAN differs from ANSI-FORTRAN. The differences which were used by SPECTRANS-2 can be found in [6]./

Peripherials: 1 tape reader

1 line printer

3 magnetic tapes: 1677 DPSC-Library

/this tape was opened on 15th January 1972. Time of preservation is 3 years./

PLOTTER tape

Scratch tape

1 off-line plotter

/The description of the plotter code is given in [5]. The subroutine DPP for drawing a coordinate system is built up from the usual plotter subroutines [7]./

A core of 25200 words is needed.

The longest running time for an operation is about 3 minutes.

The code can carry out nine different operations with different input and output data. These modes of operation are listed as follows.

The modes of operation

1. The first mode of the operation is denoted by RUN.

Its tasks are detailed as follows.

1.1. It transforms the input spectrum which may be given in five different forms into φ /u/ spectrum.

1.1.1. φ/E/ $\quad \varphi/u_i/ = \varphi/E_i/ \cdot E_i$

1.1.2. φ/u/

1.1.3. $\varphi/u^{GY}/$ $\quad$ **where GY means the length of the lethargy interval**

$\varphi/u_i/ = \varphi(u^{GY}) / GY$

1.1.4. $F/E_n/$ is the number of the neutrons in an energy interval of arbitrary length

$$\varphi(u_i) = \frac{F(E_i)\sqrt{E_i \cdot E_{i+1}}}{E_{i+1} - E_i}$$

TH = 0.468 * TH' /see Appendix 1/

TH' is the number of the thermal neutrons.

TH means the thermal flux per unit lethargy.

1.1.5. If the spectrum is given by the Abagian system, then the calculation method is the same as in 1.1.4. but the transformation factors are incorporated in the code. /see Appendix 2/

1.2. It makes the standardized spectrum in 48 predetermined intervals in terms of φ /u/ /see II./

1.3. It computes the following data:

1.3.1. φ/E/ spectrum $\quad \varphi/E_k/ = \varphi(u_k) / E_k$

1.3.2. kerma spectrum

$$K/E_k/ = \varphi/E_k/ \cdot C_1$$

$$K/u_k/ = K/E_k/ \cdot E_k$$

1.3.3. Dose-equivalent spectrum $D/E_k/ = \varphi/E_k/ \cdot C_2$

$$D/u_k/ = D/E_k/ \cdot E_k$$

Where C_1 and C_2 are the conversion factors from flux to kerma and dose-equivalent. /see Appendix 3/

1.3.4. Normalized $\varphi/u/$ spectrum

$$\varphi(u_k)^n = \frac{\varphi(u_k)}{\sum_1^{48} \varphi(u_k)}$$

Where the denominator is called the normalizing factor.

1.3.5. Normalized $K/u/^n$ and $D/u/^n$ spectra. These normalizations are done by the manner described above.

1.3.6. Thermal kerma and dose-equivalent:

$$THK = \frac{TH}{0.468} * 8.27 * 10^{-12} \quad \text{and}$$

$$THD = \frac{TH}{0.468} * 10^{-9}, \text{ respectively.}$$

1.3.7. The dose fractions by the following method: If DL/K/ is the length of the lethargy interval and $S = \sum_1^{48} D(u_k) \cdot DL(K)$ /It means the sum of dose without thermal dose/ as well as $ST = S + THD$ /sum of dose with thermal dose/

then the normalized dose-equivalent spectrum without thermal dose is

$$RDE/K/ = \frac{D(u_k) . DL(K)}{S}$$

with the thermal dose

$$RDET/K/ = \frac{D(u_k) . DL(K)}{ST}$$

In the latter case the normalized thermal dose-equivalent is THD/ST

The dose fractions are computed by the under-mentioned expressions in $[E_m , E_n]$ interval:

without thermal dose: $\sum_m^n RDE/K/$ with thermal dose: $\sum_m^n RDET/K/$

1.3.8. The flux fractions. These are calculated in the same manner as the dose fractions with thermal dose described in the previous paragraph.

1.3.9. The average energy:

$$\tilde{E} = \frac{TH * 0.0252 + \sum_1^{48} \varphi(u_k) * E_k}{TH + \sum_1^{48} \varphi(u_k)}$$

The energy of the thermal neutrons is taken as 0.025 eV in the thermal equilibrium case from the Maxwellian distribution.

1.3.10. The normalized $\varphi(u)*du$ as well as normalized $D(u)*du$ spectra /also thermal neutrons are taken into account./

1.4. The normalized $\varphi/u/^n$, $K/u/^n$ and $D/u/^n$ spectra are drawn by an off-line operated plotter.

1.5. Input data

The input data must be given in records.

1.5.1. The first record contains the word RUN in A8 format.

1.5.2. The first eight characters of the second record /format 10A8/ contain the spectrum identification number. A short information about the spectrum may be placed in the next 72 character positions. Both this text and the identification number will be written under each figure which are drawn by a plotter as detailed in 1.4.

1.5.3. The detailed information about the spectrum may be written in the next five records /3-7/ in 10A8 format.

1.5.4. The eighth record contains N, K1, KN /format 3I0/ N is the number of the input points of the flux $(6 \leq N \leq 200)$ if the input spectrum is given in terms of 1.1.1., 1.1.2., 1.1.3. or 1.1.5. In case of 1.1.4. $N < 0$ but $|N|$ is equal to the number of the input points.

K1, KN: Serial numbers of the standardized energy points. The interpolation begins from K1 and is terminated by KN. Arbitrary values may be given to K1 and KN in the input list, provided the condition $1 \leq K1 \leq |KN| \leq 48$ is fulfilled.

/If KN < O, then no plot will be at all./

Let EIN/I/ be a variable which gives the energy base points of the input spectrum /in eV/ in increasing order as well as ESTAND/K/ means the set of the standardized energy points. If ESTAND /K1/ < EIN/1/, then the current value of K1 is increased by 1 until ESTAND/K1/ > EIN/1/. Similarly, if ESTAND/KN/ > EIN/N/, then KN is decremented by 1 until ESTAND/KN/ < EIN/N/. If ESTAND/K1/ > EIN/1/ and ESTAND/KN/ < EIN/N/, then the calculations described above are made in the energy interval ESTAND/K1/ ÷ ESTAND/KN/.

1.5.5. The record 9 contains the variable ZZ /format FO.0/ If ZZ > O, then both EIN/I/ and F/I/ must be given in input list. If ZZ < O, then only F/I/ must be specified, in this case the previous set of EIN/I/ will be used in the calculations. Variable F/I/ gives the input spectrum which may be given in five different forms /see 1.1./.

1.5.6. In the following 2N+1 records the variable EIN/I/, TH andF/I/ are placed /format FO.0/ if ZZ > O and N > O.

If ZZ > O but N < O, then 2N+2 records are needed because variable EIN/I/ has N+1 different values /the limits of the energy intervals/. The order of the variables should be EIN/I/, TH and F/I/ as in the previous case.

If ZZ $<$ 0, then only TH and F/I/ are given therefore only N+1 records are needed.

1.5.7. Variable Z is in the next record /format F0.0/ According to the type of the input spectrum detailed in 1.1. values of Z may be:

Z $<$ 0 in case of 1.1.1.

Z $>$ 0 " 1.1.2., 1.1.3. and 1.1.5.

Omit this record in case of 1.1.4.

1.5.8. The next record contains the variable GY. /format F0.0/

Values of GY may be:

GY: arbitrary in case of 1.1.1.

GY = 1.0 in case of 1.1.2.

GY equals the lenght of the lethargy interval in which the input spectra is given in case of 1.1.3.

Omit this record in case of 1.1.4.

GY = 0.77 in case of 1.1.5.

1.5.9. Values of variable IPØS given in the next record /format I0/ may be:

IPØS = 0 if only the flux spectrum is to be drawn.

IPØS = 1 if all the spectra given in 1.4. are to be drawn.

1.5.10. The last record has two variables KU and KUK /format 2I0/

If IPØS = 0, then neither KU nor KUK are needed.

If IPØS = 1, then value of KU and KUK must be given.

KU regulates the grades of the linear scale of the $\gamma(u)^n$ axis as well as KUK does the same on the common axis of the $K/u/^n$ and $D/u/^n$ spectra. /see Appendix 5/ Both KU and KUK may be equal to 1, 2, 3, 4, 5, 6 or 7, when the first grades on the linear $\gamma/u/^n$, $K/u/^n$ and $D/u/^n$ axes are equal to 0.2, 0.1, 0.05, 0.04, 0.025, 0.02 or 0.01, respectively.

If KU or KUK is identical with 0, then the code itself chooses the appropriate grade of axes. The values of KU and KUK are independent from each other.

1.6. Output data those were calculated and mentioned from 1.3.1. until 1.3.10. are printed by a line printer. A sample is presented in Appendix 4.

2. <u>The second mode of the operation is denoted by ADD.</u>

It makes just the same tasks as the mode RUN but in addition it writes the following data on the library tape: identification number and comments about the input spectrum, the input spectrum in its native form and the standardized spectrum as well as the normalizing factor. The first record must be the word ADD /format A8/ in the input list. The other records must be composed in the same way as it can be read in 1.5.

Output data are the same as in 1.6.

3. The third mode of the operation is denoted by PLΘT.

3.1. It reads the original and the standardized neutron spectra from the library tape, prints out these spectra by a line-printer. Only the flux spectrum will be drawn by an off line plotter.

The input list must be given in the following form:

3.1.1. The first record contains the word PLΘT. /format A8/

3.1.2. In the second record the identification number of the spectrum is placed /format A8/

3.1.3. The record 3 contains the variable IPLΘT /format I0/

IPLΘT = 0

3.1.4. In the fourth record the variable IPΘS is placed /format I0/

IPΘS = 0

3.2. If all the data which can be computed by the mode RUN /see 1.3. and 1.4./ are needed, then the modified version of mode PLΘT must be used. In this case both the original and the standardized spectra will be read from the library and the code calculates the required data as it is written in 1.3. It runs with the following input list:

3.2.1. The first record contains the word PLΘT; /format A8/

3.2.2. The identification number of the spectrum must be given in the second record. /format A8/

3.2.3. The third record contains the variable IPLØT /format I0/ IPLØT=1

3.2.4. The next two records are identical with 1.5.9. and 1.5.10.

3.3. Output data for the first mode of operation named PLØT can be seen in Appendix 6, output data for the second mode are the same as in 1.6.

4. The fourth mode of the operation is denoted by EDIT.

The original and the standardized spectra of the library tape will be printed by a line printer. The input list has only two records:

4.1. The first record contains the word EDIT. /format A8/

4.2. The identification number must be filled in the second record /format A8/.

4.3. If it is required to write out the whole content of the library tape only one record is needed namely the word LØNGEDIT /format A8/.

4.4. A sample of output data is presented in Appendix 6. If the spectrum was written by operation named FTAPE on the Library, then only the output spectrum would be printed.

5. The fifth mode of operation is denoted by LIST.

In this mode the program writes out only the identification numbers and the comments about the spectra from the tape.

5.1. If it is needed to get a total list of the content of the library then the input list must consist of only two records and the word LIST must be placed in both records. /format A8/

5.2. If one wants to know the content of the library tape only from a spectrum given with its identification number, then the records of the input list are:

5.2.1. The first one contains the word LIST. /format A8/

5.2.2. The identification number must be given in the second record. /format A8/

5.3. A sample of output data is presented in Appendix 7.

6. <u>The sixth mode of the operation is denoted by DELETE.</u>

If it is required to delete any spectrum given by its identification number, then the input list must be written as it follows here:

6.1. The first record contains the word DELETE. /format A8/

6.2. The identification number is placed in the second record /format A8/

6.3. No output data on the printer.

7. <u>The seventh mode of operation is denoted by Θ5RK.</u>

The input spectrum may be taken as one of the outputs of the Θ5R code adapted and modified by I. Lux and L.Koblinger [2] The modified Θ5R code distributes M neutrons among the standardized 48 energy intervals during one run. To decrease the error of statistics more than one /N/ run are needed and the Θ5RK mode of the SPECTRANS-2 code accumulates the numbers of neutrons calculated by Θ5R during the runs and makes φ/u/ spectrum. /see 1.1.4./ After normalizing /see 1.3.4./ both the sum and the φ /u/^{n} spectrum as well as the normalizing factor and comments about the spectrum will be written on the library tape.

The form of the input list /compiled and punched by Θ5R code/ is:

7.1. The first record contains the word Θ5RK /format A8/

7.2. The content of the next six records is detailed in 1.5.2. and 1.5.3.

7.3. The eight record contains the variable N /see above/. /format IO/

7.4. N times 48 records contain the number of neutrons distributed among 48 energy intervals. /format F0.0/

7.5. In the last record the word ENDEND must be written. /format A8/

7.6. Output data

Comment about the spectrum and the calculated spectrum is printed. See Appendix 8.

8. <u>The eighth mode of operation is denoted by FTAPE.</u>

This mode is siutable to calculate the leakage spectrum for a given intermediate thickness between two known thicknesses of a shielding material on the assumption that the attenuation is exponential in the whole energy range /It is rightful, naturally, if the difference between the thicknesses is low./

Let the flux of neutron be φ_{i1} and φ_{i2} penetrating x_1 and x_2 layer, respectively in the E_i energy interval and φ_{ik} is the flux behind the thickness of x_k;/$x_1 < x_k < x_2$/. x_k can be written by the following expression

$$x_k = \frac{ax_1 + bx_2}{a + b} \qquad \text{where} \qquad \frac{b}{a} = \frac{x_k - x_1}{x_2 - x_k}$$

Using the formula of attenuation

$$\varphi = \varphi_0 \exp(-\sigma x)$$

we obtain:

$$\varphi_{ik} = \varphi_{i1}^{\frac{a}{a+b}} * \varphi_{i2}^{\frac{b}{a+b}}$$

The program reads φ_1 and φ_2 from the library and writes φ_K on it. It calculates all the same data which are mentioned in 1.3. and the spectra will be drawn by a plotter.

The input list is to be compiled in the following way:

8.1. The first record contains the word FTAPE. /formatA8/

8.2. The identification number of the spectrum which belongs to x_1 thickness is to be written in the second record. /format A8/

8.3. In record 3 the identification number of the second known spectrum is to be placed. /format A8/

8.4. The fourth record contains the value of x_k /format A8/. These eight characters will form a part of the comment of the new interpolated spectrum.

8.5. The fifth record contains the variables X_k, X_1, X_2. These mean the values of the thicknesses /format 3F0.0/.

8.6. The next record contains the identification number of the new interpolated spectrum /format A8/.

8.7. The last two records are the same as 1.5.9. and 1.5.10.

8.8. The used two spectra as well as the calculated spectrum is printed as it can be seen in Appendix 9.

9. The nineth mode of the operation is denoted by DOSEVA.

It has two versions.

9.1. The first of them standardizes the response of any kind of dosimeters by the method described in II. Both the responses /the original and the standardized/ will be written on the library and printed by a line printer. The following input is necessary:

9.1.1. The first record contains the word DØSEVA /format A8/.

9.1.2. Variables N, NW, NY are placed in the second record /format 3I0/.

N means the number of the input points of the response

NW=1

NY is an arbitrary integer.

9.1.3. The following six records are the same as 1.5.2. and 1.5.3.

9.1.4. EIN/I/, TH, F/I/ are in the next 2N+1 records /format F0.0/.

EIN/I/ gives the energy base points of the input response.

TH is the thermal response.

F/I/ contains the values of the input response.

9.1.5. Output data

The original and the standardized response will be printed. See Appendix 10.

9.2. The reading /R/ of a dosimeter is calculated in the second version. Both the response and the spectrum are read from the library and the method of the calculation is the following:

$$R = \frac{\sum \left(RESP(E_k) * SP(E_k)\right)}{\sum SP(E_k)}$$

The input list:

9.2.1. The first record is the word DØSEVA /format A8/.

9.2.2. The second record contains the variables

N, NW, NY /format 3I0/.

N is an arbitrary integer.

NW=0

NY=0 if $SP/E_k/ = K/u_k/ \cdot du_k$

NY=1 if $SP/E_k/ = D/u_k/ \cdot du_k$

NY=2 if $SP/E_k/ = \varphi/u_k/ \cdot du_k$

9.2.3. The third record contains the identification number of the required spectrum /format A8/.

9.2.4. In the next record the identification number of the response function is placed.

9.2.5. Output data

Both the response and the used spectrum as well as the reading of the dosimeter will be printed and drawn by an off line plotter. See Appendix 11.

10. It should be noted that:

10.1. The modes mentioned 1 to 9 may follow each other in any order in the input list but the input list must be finished with the word ENDEND /format A8/.

10.2. The input list should begin with the word NEWTAPE /format A8/ if it is necessary to delete the whole library or to begin a new library tape.

IV. Note

When the name of the operation is absent in the input list, then the code writes the following message: "Error in input date" and writes out all the faulty data, too. The program is continued from the next operation.

Acknowledgement

The author is indebted to Mr. S. Makra for his contribution. Thanks are due to Mr. L. Koblinger and Mr. P. Zaránd for the helpful discussions as well as to Miss M. Bérces for the careful typing and drawing.

References

[1] I.N. Bronstein, K.A. Semendiaev: Mathematical Handbook MK. Budapest, 1963. pp. 723-724. /in Hungarian/

[2] I. Lux and L. Koblinger KFKI-73-2.

[3] J.A. Dennis, H.J. Delafield, P.D. Holt, S.J. Boot: AERE-R 6498, June, 1970.

[4] D. Nachtigall, F. Rohloff: JÜl-213-ST /1964/.

[5] ICT 1900 Series, Graph Plotter, Technical Publication 4087, ICT, Letchworth, Hertfordshire, Great Britain, 1968.

[6] Technical Publication 4261, ICL Printing Service, at Letchworth, Hertfordshire.

[7] KFKI Programozási Tájékoztató 1972/5 /in Hungarian/

Appendix 1

The energy distribution of neutrons with energies smaller than 0.217 eV /thermal neutrons/ was considered to be Maxwellian. The peak of the distribution is at E=1.5 kT in a linear lethargy scale, and the differential flux density at this point is $2 * (1.5)^{1/2} * \exp(-1.5) = 0.468 *$ flux density of the thermal range.

Appendix 2

Energy range		Lethargy	Factors to 0.77 lethargy interval
10.5 - 6.5	MeV	0.48	1.604
6.5 - 4.0	MeV	0.48	1.604
4.0 - 2.5	MeV	0.48	1.604
2.5 - 1.4	MeV	0.57	1.351
1.4 - 0.8	MeV	0.57	1.351
0.8 - 0.4	MeV	0.69	1.116
0.4 - 0.2	MeV	0.69	1.116
0.2 - 0.1	MeV	0.69	1.116
100 - 46.5	keV	0.77	--
46.5 - 21.5	keV	0.77	--
21.5 - 10	keV	0.77	--
10 - 4.65	keV	0.77	--
4.65 - 2.15	keV	0.77	--
2.15 - 1.0	keV	0.77	--
1.0 - 0.465	keV	0.77	--
465 - 215	eV	0.77	--
215 - 100	eV	0.77	--
100 - 46.5	eV	0.77	--
46.5 - 21.5	eV	0.77	--
21.5 - 10	eV	0.77	--
10 - 4.65	eV	0.77	--
4.65 - 2.15	eV	0.77	--
2.15 - 1.0	eV	0.77	--
1.0 - 0.465	eV	0.77	--
0.465 - 0.215	eV	0.77	--
0.0252	eV	--	0.36

Appendix 3

Conversion factors [3] , [4]

No.	Kerma /rad.n^{-1}.cm^{2}/	rem-dose /rem.n^{-1}.cm^{2}/
Thermal	8.27E-12	1.00E-09
1	6.99E-12	1.12E-09
2	5.53E-12	1.15E-09
3	3.90E-12	1.16E-09
4	2.72E-12	1.21E-09
5	1.88E-12	1.24E-09
6	1.29E-12	1.27E-09
7	9.90E-13	1.32E-09
8	9.00E-13	1.34E-09
9	1.09E-12	1.38E-09
10	1.75E-12	1.35E-09
11	3.30E-12	1.31E-09
12	6.70E-12	1.30E-09
13	1.47E-11	1.24E-09
14	3.16E-11	1.21E-09
15	6.70E-11	1.21E-09
16	1.12E-10	1.59E-09
17	1.40E-10	1.88E-09
18	1.70E-10	2.26E-09
19	2.10E-10	2.65E-09
20	2.50E-10	3.20E-09
21	3.05E-10	3.75E-09
22	3.65E-10	4.50E-09
23	4.30E-10	5.38E-09
24	5.20E-10	6.37E-09
25	6.10E-10	7.67E-09
26	7.10E-10	9.10E-09
27	8.20E-10	1.10E-08
28	9.50E-10	1.29E-08
29	1.09E-09	1.52E-08
30	1.23E-09	1.85E-08
31	1.40E-09	2.14E-08
32	1.59E-09	2.54E-08
33	1.79E-09	2.92E-08
34	2.00E-09	3.09E-08
35	2.20E-09	3.64E-08
36	2.38E-09	3.86E-08
37	2.50E-09	4.00E-08
38	2.90E-09	4.08E-08
39	3.10E-09	4.14E-08
40	3.40E-09	4.17E-08
41	4.20E-09	4.17E-08
42	4.20E-09	4.19E-08
43	4.50E-09	4.21E-08
44	5.10E-09	4.22E-08
45	4.90E-09	4.22E-08
46	5.45E-09	4.25E-08
47	6.80E-09	4.25E-08
48	7.30E-09	4.25E-08

NEUTRON SPECTRUM TRANSFORMATION

00000098 00000097 SP THROUGH 1 CM AL
ASSUMING EXPONENTIAL ATTENUATION
APPROACH FOR VINCA SP
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INPUT DATA

NUMBER OF THE INPUT ENERGY GROUPS: 23

APPENDIX 4/a
TO OPERATIONS NAMED
RUN, ADD AND PLOT (2)

	ENERGY EV	FLUX IS GIVEN IN ABAGIAN SYSTEM
1	1.58000E 00	2.69100000E 01
2	3.40000E 00	2.18900000E 01
3	7.33000E 00	1.10500000E 01
4	1.58000E 01	1.64100000E 00
5	3.40000E 01	1.69600000E 00
6	7.33000E 01	1.83300000E 00
7	1.58000E 02	2.03600000E 00
8	3.40000E 02	2.10000000E 00
9	7.33000E 02	2.16700000E 00
10	1.58000E 03	2.16900000E 00
11	3.40000E 03	2.33600000E 00
12	7.33000E 03	2.63700000E 00
13	1.58000E 04	2.55300000E 00
14	3.40000E 04	3.44100000E 00
15	7.33000E 04	2.68400000E 00
16	1.50000E 05	3.13100000E 00
17	3.00000E 05	3.71900000E 00
18	6.00000E 05	3.69900000E 00
19	1.10000E 06	4.47700000E 00
20	1.95000E 06	3.36400000E 00
21	3.25000E 06	3.10700000E 00
22	5.25000E 06	1.65500000E 00
23	8.50000E 06	5.32100000E-01

CALCULATED DATA

NUMBER OF THE STANDARD ENERGY GROUPS: 48

	STANDARD ENERGY EV	LIMITS OF THE ENERGY GROUPS E EV	E EV	LETHARGY INTERVALS	PHI(E)	E*PHI(E)
1	0.21701E 00	0.18845E 00	0.25000E 00	0.2710	0.00000E 00	0.00000E 00
2	0.35356E 00	0.25000E 00	0.50000E 00	0.6930	0.00000E 00	0.00000E 00
3	0.70715E 00	0.50000E 00	0.10000E 01	0.6930	0.00000E 00	0.00000E 00
4	0.14663E 01	0.10000E 01	0.21500E 01	0.7660	0.00000E 00	0.00000E 00
5	0.31619E 01	0.21500E 01	0.46500E 01	0.7660	0.92940E-01	0.29387E 02
6	0.68191E 01	0.46500E 01	0.10000E 02	0.7660	0.23729E 01	0.16181E 02
7	0.14663E 02	0.10000E 02	0.21500E 02	0.7660	0.25721E 00	0.37715E 01
8	0.31619E 02	0.21500E 02	0.46500E 02	0.7660	0.69365E-01	0.21933E 01
9	0.68191E 02	0.46500E 02	0.10000E 03	0.7660	0.34570E-01	0.23574E 01
10	0.14663E 03	0.10000E 03	0.21500E 03	0.7660	0.17791E-01	0.26088E 01
11	0.31619E 03	0.21500E 03	0.46500E 03	0.7660	0.85910E-02	0.27164E 01
12	0.68191E 03	0.46500E 03	0.10000E 04	0.7660	0.41105E-02	0.28030E 01
13	0.14663E 04	0.10000E 04	0.21500E 04	0.7660	0.19208E-02	0.28165E 01
14	0.31619E 04	0.21500E 04	0.46500E 04	0.7660	0.95050E-03	0.30054E 01
15	0.68191E 04	0.46500E 04	0.10000E 05	0.7660	0.49477E-03	0.33739E 01
16	0.11220E 05	0.10000E 05	0.12589E 05	0.2300	0.30076E-03	0.33746E 01
17	0.14125E 05	0.12589E 05	0.15848E 05	0.2300	0.23626E-03	0.33372E 01
18	0.17816E 05	0.15848E 05	0.19951E 05	0.2300	0.19327E-03	0.34433E 01
19	0.22385E 05	0.19951E 05	0.25117E 05	0.2300	0.16676E-03	0.37328E 01
20	0.28182E 05	0.25117E 05	0.31620E 05	0.2300	0.14549E-03	0.41002E 01
21	0.35478E 05	0.31620E 05	0.39805E 05	0.2300	0.12492E-03	0.44319E 01
22	0.44663E 05	0.39805E 05	0.50112E 05	0.2300	0.94084E-04	0.42021E 01
23	0.56226E 05	0.50112E 05	0.63086E 05	0.2300	0.69591E-04	0.39128E 01
24	0.70782E 05	0.63086E 05	0.79418E 05	0.2300	0.50136E-04	0.35487E 01
25	0.89117E 05	0.79418E 05	0.10000E 06	0.2300	0.40457E-04	0.36054E 01
26	0.11220E 06	0.10000E 06	0.12589E 06	0.2300	0.33491E-04	0.37801E 01
27	0.14125E 06	0.12589E 06	0.15848E 06	0.2300	0.28319E-04	0.40000E 01
28	0.17816E 06	0.15848E 06	0.19951E 06	0.2300	0.23628E-04	0.42096E 01
29	0.22385E 06	0.19951E 06	0.25117E 06	0.2300	0.19845E-04	0.44422E 01
30	0.28182E 06	0.25117E 06	0.31620E 06	0.2300	0.16810E-04	0.47373E 01
31	0.35478E 06	0.31620E 06	0.39806E 06	0.2300	0.13887E-04	0.49269E 01
32	0.44663E 06	0.39806E 06	0.50112E 06	0.2300	0.11395E-04	0.50895E 01
33	0.56226E 06	0.50112E 06	0.63086E 06	0.2300	0.94161E-05	0.52943E 01
34	0.70782E 06	0.63086E 06	0.79418E 06	0.2300	0.79177E-05	0.56043E 01
35	0.89117E 06	0.79418E 06	0.10000E 07	0.2300	0.67527E-05	0.60178E 01
36	0.11220E 07	0.10000E 07	0.12589E 07	0.2300	0.57460E-05	0.64470E 01
37	0.14125E 07	0.12589E 07	0.15848E 07	0.2300	0.41739E-05	0.58957E 01
38	0.17816E 07	0.15848E 07	0.19951E 07	0.2300	0.29160E-05	0.51952E 01
39	0.22385E 07	0.19951E 07	0.25117E 07	0.2300	0.22352E-05	0.50034E 01
40	0.28182E 07	0.25117E 07	0.31620E 07	0.2300	0.18665E-05	0.52601E 01
41	0.35478E 07	0.31620E 07	0.39806E 07	0.2300	0.14296E-05	0.50720E 01
42	0.44663E 07	0.39806E 07	0.50112E 07	0.2300	0.87366E-06	0.39023E 01
43	0.56226E 07	0.50112E 07	0.63086E 07	0.2300	0.47984E-06	0.26979E 01
44	0.70782E 07	0.63086E 07	0.79418E 07	0.2300	0.26756E-06	0.18938E 01
45	0.89117E 07	0.79418E 07	0.10000E 08	0.2300	0.00000E 00	0.00000E 00
46	0.11220E 08	0.10000E 08	0.12589E 08	0.2300	0.00000E 00	0.00000E 00
47	0.14125E 08	0.12589E 08	0.15848E 08	0.2300	0.00000E 00	0.00000E 00
48	0.17816E 08	0.15848E 08	0.19951E 08	0.2300	0.00000E 00	0.00000E 00

THERMAL FLUX PER UNIT LETHARGY: 0.00000E-01

APPENDIX 4/b
TO OPERATIONS NAMED
RUN, ADD AND PLOT (2)

SPECTRA NORMALIZED TO UNIT AREA

	E*PHI(E)	E*KERMA(E)	E*REM-DOSE(E)
1	0.00000E 00	0.00000E 00	0.00000E 00
2	0.00000E 00	0.00000E 00	0.00000E 00
3	0.00000E 00	0.00000E 00	0.00000E 00
4	0.00000E 00	0.00000E 00	0.00000E 00
5	0.14814E 00	0.25122E-03	0.12156E-01
6	0.81568E-01	0.94916E-04	0.68443E-02
7	0.19012E-01	0.16978E-04	0.16645E-02
8	0.11056E-01	0.89760E-05	0.97817E-03
9	0.11884E-01	0.11684E-04	0.10836E-02
10	0.13151E-01	0.20760E-04	0.11757E-02
11	0.13693E-01	0.40762E-04	0.11861E-02
12	0.14130E-01	0.85397E-04	0.12118E-02
13	0.14198E-01	0.18827E-03	0.11651E-02
14	0.15150E-01	0.43186E-03	0.12162E-02
15	0.17008E-01	0.10279E-02	0.13653E-02
16	0.17011E-01	0.17186E-02	0.17840E-02
17	0.16823E-01	0.21245E-02	0.20868E-02
18	0.17358E-01	0.26618E-02	0.25962E-02
19	0.18817E-01	0.35646E-02	0.32948E-02
20	0.20669E-01	0.46611E-02	0.43734E-02
21	0.22341E-01	0.61466E-02	0.55427E-02
22	0.21163E-01	0.69744E-02	0.62988E-02
23	0.19725E-01	0.76509E-02	0.70156E-02
24	0.17889E-01	0.83912E-02	0.75373E-02
25	0.18175E-01	0.10001E-01	0.92165E-02
26	0.19056E-01	0.12204E-01	0.11470E-01
27	0.20164E-01	0.14915E-01	0.14640E-01
28	0.21221E-01	0.18185E-01	0.18115E-01
29	0.22393E-01	0.22018E-01	0.22462E-01
30	0.23861E-01	0.26496E-01	0.29181E-01
31	0.24837E-01	0.31365E-01	0.35112E-01
32	0.25657E-01	0.36798E-01	0.43057E-01
33	0.26689E-01	0.43094E-01	0.51601E-01
34	0.28251E-01	0.50969E-01	0.57723E-01
35	0.30336E-01	0.60202E-01	0.73035E-01
36	0.32500E-01	0.69773E-01	0.82993E-01
37	0.29720E-01	0.67023E-01	0.78608E-01
38	0.26129E-01	0.68510E-01	0.70705E-01
39	0.25222E-01	0.70530E-01	0.69012E-01
40	0.26517E-01	0.81325E-01	0.73044E-01
41	0.25568E-01	0.96868E-01	0.70432E-01
42	0.19670E-01	0.74523E-01	0.54537E-01
43	0.13660E-01	0.55207E-01	0.37833E-01
44	0.95470E-02	0.43920E-01	0.26646E-01
45	0.00000E 00	0.00000E 00	0.00000E 00
46	0.00000E 00	0.00000E 00	0.00000E 00
47	0.00000E 00	0.00000E 00	0.00000E 00
48	0.00000E 00	0.00000E 00	0.00000E 00

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 1.98372E 02
FACTOR TO E*KER(E) 2.19912E-07
FACTOR TO E*REM(E) 3.00005E-06

THERMAL NEUTRON KERMA: 0.00000E-01
THERMAL NEUTRON DOSE: 0.00000E-01

	KERMA(E)	REM-DOSE(E)
1	0.00000E 00	0.00000E 00
2	0.00000E 00	0.00000E 00
3	0.00000E 00	0.00000E 00
4	0.00000E 00	0.00000E 00
5	0.17473E-10	0.11534E-07
6	0.30610E-11	0.30112E-08
7	0.25464E-12	0.34055E-09
8	0.62429E-13	0.92810E-10
9	0.37682E-13	0.47673E-10
10	0.31135E-13	0.24054E-10
11	0.28350E-13	0.11254E-10
12	0.27540E-13	0.53313E-11
13	0.28236E-13	0.23838E-11
14	0.30036E-13	0.11539E-11
15	0.33149E-13	0.60065E-12
16	0.33686E-13	0.47701E-12
17	0.33076E-13	0.44322E-12
18	0.32856E-13	0.43718E-12
19	0.35019E-13	0.44157E-12
20	0.36372E-13	0.46556E-12
21	0.38100E-13	0.46869E-12
22	0.34341E-13	0.42310E-12
23	0.29924E-13	0.37433E-12
24	0.26071E-13	0.31946E-12
25	0.24679E-13	0.31027E-12
26	0.23921E-13	0.30669E-12
27	0.23221E-13	0.31094E-12
28	0.22447E-13	0.30504E-12
29	0.21631E-13	0.30104E-12
30	0.20676E-13	0.31064E-12
31	0.19442E-13	0.29691E-12
32	0.18119E-13	0.28922E-12
33	0.16855E-13	0.27533E-12
34	0.15835E-13	0.24466E-12
35	0.14856E-13	0.24587E-12
36	0.13675E-13	0.22191E-12
37	0.10435E-13	0.16696E-12
38	0.84565E-14	0.11906E-12
39	0.69290E-14	0.92491E-13
40	0.63461E-14	0.77758E-13
41	0.60044E-14	0.59558E-13
42	0.36694E-14	0.36633E-13
43	0.21593E-14	0.20187E-13
44	0.13646E-14	0.11294E-13
45	0.00000E 00	0.00000E 00
46	0.00000E 00	0.00000E 00
47	0.00000E 00	0.00000E 00
48	0.00000E 00	0.00000E 00

APPENDIX 4/c
TO OPERATIONS NAMED
RUN, ADD AND PLOT (2)

DOSE FRACTIONS

	WITHOUT THERMAL NEUTRON DOSE	WITH THERMAL NEUTRON DOSE
LESS THAN 0.5EV	0.00000	0.00000
0.5EV-1.0EV	0.00000	0.00000
1.0EV-1.0KEV	0.08186	0.08186
1.0KEV-10.0KEV	0.01166	0.01166
10.0KEV-0.1MEV	0.04649	0.04649
0.1MEV-0.5MEV	0.16265	0.16265
0.5MEV-0.794MEV	0.10217	0.10217
0.794MEV-1.0MEV	0.06826	0.06826
1.0MEV-1.58MEV	0.15103	0.15103
1.58MEV-2.51MEV	0.13057	0.13057
2.51MEV-15.8MEV	0.24532	0.24532
SUM OF DOSE	7.38328E-07	7.38328E-07

AVERAGE ENERGY(EV): 6.89398E 05

FLUX FRACTIONS

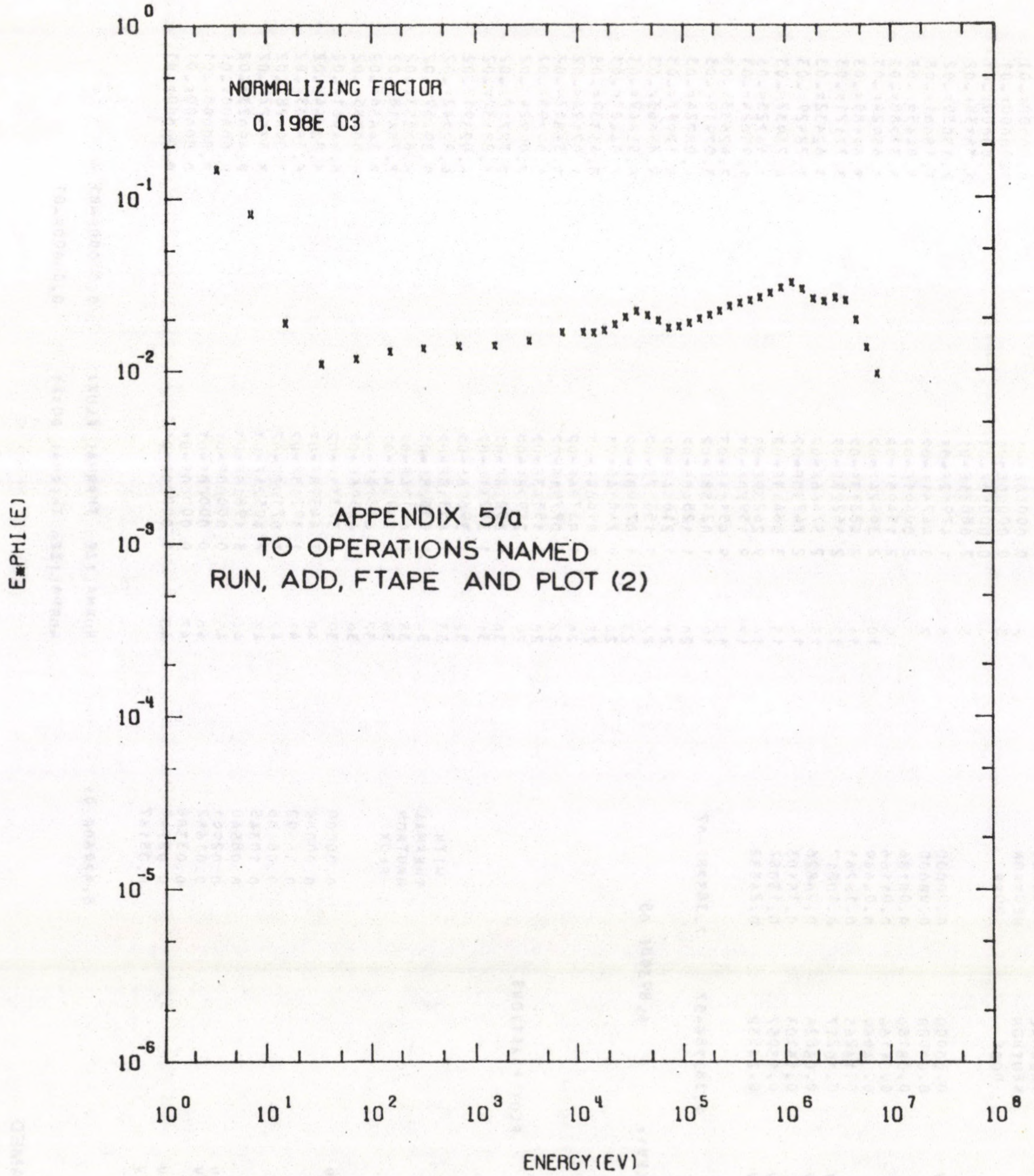
	WITH THERMAL NEUTRON FLUX
LESS THAN 0.5EV	0.00000
0.5EV-1.0EV	0.00000
1.0EV-1.0KEV	0.56692
1.0KEV-10.0KEV	0.08406
10.0KEV-0.1MEV	0.10345
0.1MEV-0.5MEV	0.08560
0.5MEV-0.794MEV	0.02991
0.794MEV-1.0MEV	0.01652
1.0MEV-1.58MEV	0.03388
1.58MEV-2.51MEV	0.02709
2.51MEV-15.8MEV	0.05167
SUM OF FLUX	8.37960E 01

	NORMALIZED PHI(U)*DU SPECTRUM WITH THERMAL NEUTRONS	NORMALIZED REM-DOSE(U)*DU SPECTRUM
1	0.00000E-01	0.00000E-01
2	0.00000E-01	0.00000E-01
3	0.00000E-01	0.00000E-01
4	0.00000E-01	0.00000E-01
5	2.68631E-01	3.78358E-02
6	1.47912E-01	2.13030E-02
7	3.44761E-02	5.18061E-03
8	2.00491E-02	3.04456E-03
9	2.15405E-02	3.37268E-03
10	2.38474E-02	3.65924E-03
11	2.48313E-02	3.69185E-03
12	2.56227E-02	3.77171E-03
13	2.57466E-02	3.62632E-03
14	2.74730E-02	3.78529E-03
15	3.08413E-02	4.24937E-03
16	9.26239E-03	1.66725E-03
17	9.15970E-03	1.95024E-03
18	9.45111E-03	2.42633E-03
19	1.02458E-02	3.07919E-03
20	1.12540E-02	4.08724E-03
21	1.21644E-02	5.17997E-03
22	1.15337E-02	5.88663E-03
23	1.07398E-02	6.55649E-03
24	9.74034E-03	7.04407E-03
25	9.89604E-03	8.61339E-03
26	1.03756E-02	1.07194E-02
27	1.09791E-02	1.36817E-02
28	1.15543E-02	1.69295E-02
29	1.21928E-02	2.09924E-02
30	1.30028E-02	2.72717E-02
31	1.35231E-02	3.28139E-02
32	1.39696E-02	4.02391E-02
33	1.45316E-02	4.82242E-02
34	1.53825E-02	5.39459E-02
35	1.65174E-02	6.82553E-02
36	1.76954E-02	7.75618E-02
37	1.61822E-02	7.34636E-02
38	1.42506E-02	6.60785E-02
39	1.37331E-02	6.44961E-02
40	1.44378E-02	6.82644E-02
41	1.39215E-02	6.58233E-02
42	1.07102E-02	5.09678E-02
43	7.40521E-03	3.53577E-02
44	5.19816E-03	2.49023E-02
45	0.00000E-01	0.00000E-01
46	0.00000E-01	0.00000E-01
47	0.00000E-01	0.00000E-01
48	0.00000E-01	0.00000E-01

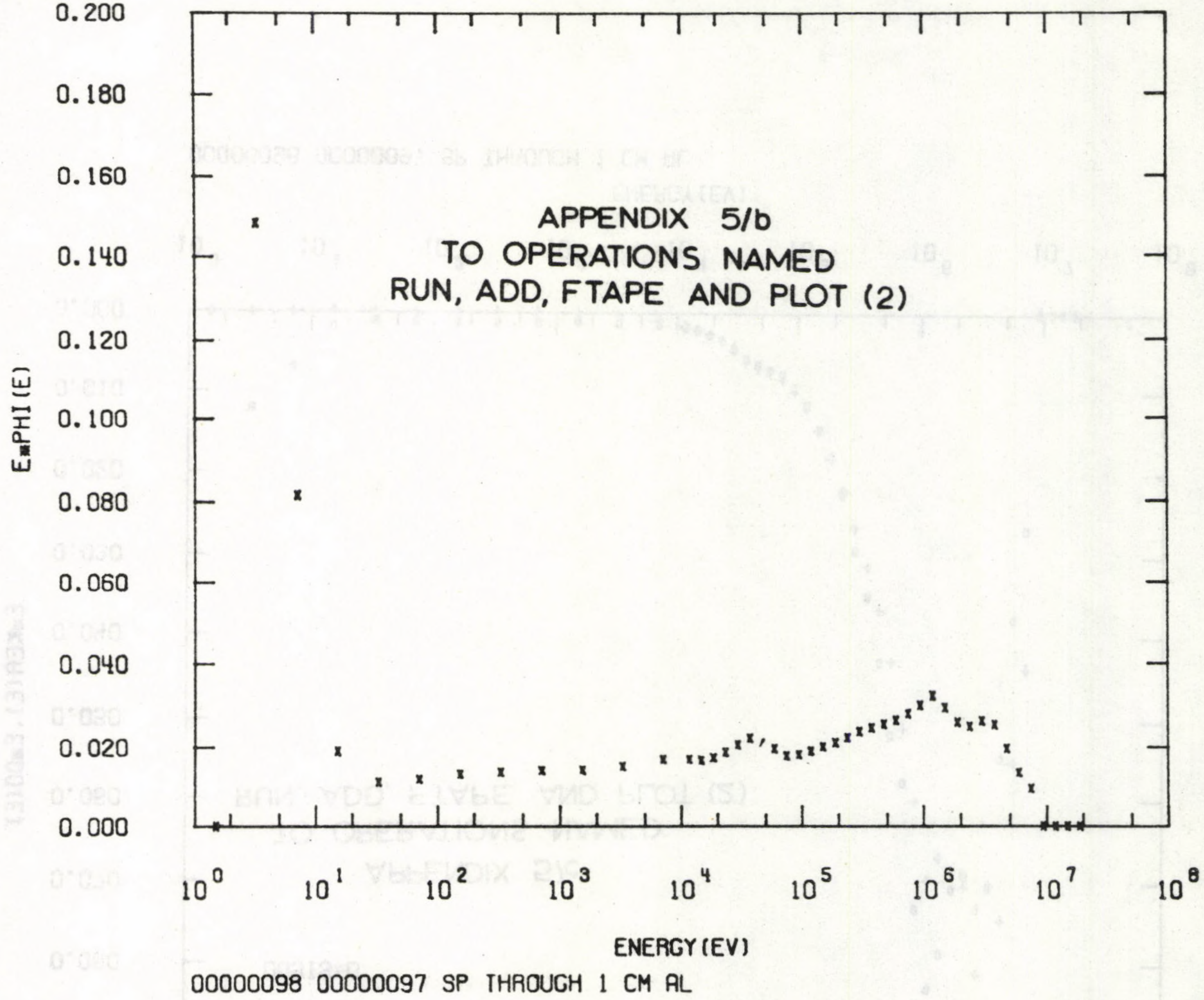
NORMALIZED THERMAL FLUX: 0.00000E-01

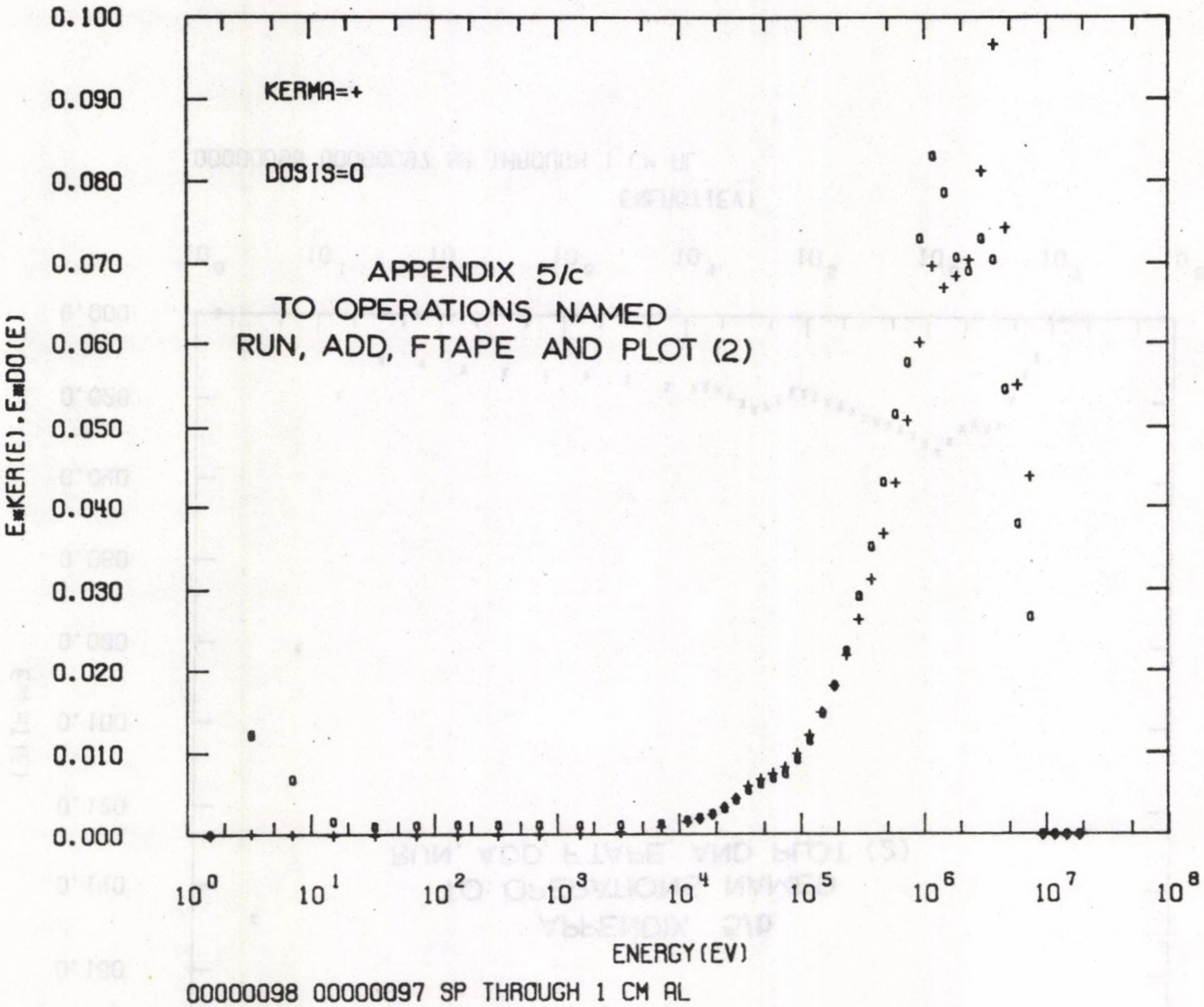
NORMALIZED THERMAL DOSE: 0.00000E-01

APPENDIX 4/d
TO OPERATIONS NAMED
RUN, ADD AND PLOT (2)



00000098 00000097 SP THROUGH 1 CM AL


APPENDIX 5/b
TO OPERATIONS NAMED
RUN, ADD, FTAPE AND PLOT (2)
E*PHI(E)
0.200
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8
ENERGY(EV)
00000098 00000097 SP THROUGH 1 CM AL


KERMA=+
DOSIS=O
APPENDIX 5/c
TO OPERATIONS NAMED
RUN, ADD, FTAPE AND PLOT (2)
E*KER(E).E*DO(E)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
ENERGY(EV)
00000098 00000097 SP THROUGH 1 CM AL

INPUT SPECTRUM

	ENERGY EV	E*PHI(E) PER 1.00000 LETHARGY INTERVAL
1	1.00000E-01	2.80000E 00
2	1.60000E-01	3.35000E 00
3	2.00000E-01	3.60000E 00
4	3.00000E-01	3.90000E 00
5	5.00000E-01	4.35000E 00
6	8.00000E-01	4.65000E 00
7	1.00000E 00	4.75000E 00
8	1.40000E 00	4.85000E 00
9	2.00000E 00	4.90000E 00
10	3.00000E 00	4.90000E 00
11	4.00000E 00	4.95000E 00
12	6.00000E 00	5.00000E 00
13	8.00000E 00	5.05000E 00
14	1.00000E 01	5.10000E 00
15	1.60000E 01	5.15000E 00
16	2.00000E 01	5.20000E 00
17	4.00000E 01	5.40000E 00
18	1.00000E 02	5.50000E 00
19	2.00000E 02	5.60000E 00
20	5.00000E 02	5.75000E 00
21	1.00000E 03	5.85000E 00
22	2.00000E 03	5.90000E 00
23	5.00000E 03	5.97000E 00
24	7.00000E 03	6.00000E 00
25	1.00000E 04	6.03000E 00
26	2.00000E 04	6.08000E 00
27	4.00000E 04	6.10000E 00
28	6.00000E 04	6.10000E 00
29	8.00000E 04	6.12000E 00
30	1.00000E 05	6.15000E 00
31	1.40000E 05	6.18000E 00
32	2.00000E 05	6.00000E 00
33	2.50000E 05	5.85000E 00
34	3.00000E 05	5.90000E 00
35	4.00000E 05	6.02000E 00
36	5.00000E 05	6.20000E 00
37	6.00000E 05	6.00000E 00
38	7.00000E 05	5.25000E 00
39	8.00000E 05	5.15000E 00
40	9.00000E 05	5.35000E 00
41	1.00000E 06	5.55000E 00
42	1.50000E 06	5.65000E 00
43	2.00000E 06	5.55000E 00
44	4.00000E 06	2.05000E 00
45	6.00000E 06	9.80000E-01
46	9.00000E 06	9.10000E-01
47	1.00000E 07	9.00000E-01

IDENTIFICATION NUMBER 00000070
O.000 70 VINCA,HEAVY WATER MODERATED REACTOR SPECTRUM
INPUT.NEUTRON ESCAPING/CORE NEUTRON
ARRIVED IN 1960
USE FOR INTERCOMPARISON IN VINCA, 1973.
**
*

OUTPUT SPECTRUM

E*PHI(E) SPECTRUM IS NORMALIZED TO UNIT AREA

	ENERGY EV	E*PHI(E)
1	2.17010E-01	1.59100E-02
2	3.53560E-01	1.74577E-02
3	7.07150E-01	1.98126E-02
4	1.46630E 00	2.10095E-02
5	3.16190E 00	2.12178E-02
6	6.81910E 00	2.17036E-02
7	1.46630E 01	2.22153E-02
8	3.16190E 01	2.29820E-02
9	6.81910E 01	2.35474E-02
10	1.46630E 02	2.39781E-02
11	3.16190E 02	2.44600E-02
12	6.81910E 02	2.50146E-02
13	1.46630E 03	2.53904E-02
14	3.16190E 03	2.56230E-02
15	6.81910E 03	2.59263E-02
16	1.12200E 04	2.60941E-02
17	1.41250E 04	2.61569E-02
18	1.78160E 04	2.62367E-02
19	2.23850E 04	2.62942E-02
20	2.81820E 04	2.63193E-02
21	3.54780E 04	2.63508E-02
22	4.46630E 04	2.63704E-02
23	5.62260E 04	2.63704E-02
24	7.07820E 04	2.64170E-02
25	8.91170E 04	2.65160E-02
26	1.12200E 05	2.66261E-02
27	1.41250E 05	2.67000E-02
28	1.78160E 05	2.62213E-02
29	2.23850E 05	2.56288E-02
30	2.81820E 05	2.54272E-02
31	3.54780E 05	2.57899E-02
32	4.46630E 05	2.63874E-02
33	5.62260E 05	2.67644E-02
34	7.07820E 05	2.26620E-02
35	8.91170E 05	2.30518E-02
36	1.12200E 06	2.40982E-02
37	1.41250E 06	2.43494E-02
38	1.78160E 06	2.41815E-02
39	2.23850E 06	2.21884E-02
40	2.81820E 06	1.78028E-02
41	3.54780E 06	1.22832E-02
42	4.46630E 06	7.78371E-03
43	5.62260E 06	5.10941E-03
44	7.07820E 06	4.12779E-03
45	8.91170E 06	3.94285E-03
46	1.12200E 07	0.00000E-01
47	1.41250E 07	0.00000E-01
48	1.78160E 07	0.00000E-01

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 2.3132[illegible]E 02

THERMAL FLUX PER UNIT LETHARGY: 0.00000E-01

APPENDIX 6
TO OPERATIONS NAMED
EDIT AND PLOT (1)

```
IDENTIFICATION NUMBER      0000089
    0000089 16000FISS MOD.D20 TR 30CM CONCR.05R H.ING
    PRELIMINERY-RESULTS
    RECEIVED IN VINCA 24.05.1973.
    ***
    **
    *


IDENTIFICATION NUMBER      0000070M
    0000070M OLD VINCA SP.REFL.FROM 20CM H20+SOURCE
    CALCULATED BY RPF1 CODE
    01.09.1973.
    ***
    **
    **


IDENTIFICATION NUMBER      0000070N
    0000070N OLD VINCA SP. THROUGH 20CM H20
    CALCULATED BY RPF1 CODE
    01.09 1973.
    ***
    **
    **


IDENTIFICATION NUMBER      0000097M
    0000097M D20 SPHERE ESCAPE SP.REFL.FROM 20CM H20+SOURCE
    ESCAPE SPECTRUM FROM D20 SPHERE
    FISSION NEUTRONS UNIFORMLY DISTRIBUTED
    CALCULATED BY H.ING
    REFLECTED FROM H20 IS CALCULATED BY RPF1 CODE
    01.09.1973.


IDENTIFICATION NUMBER      0000097N
    0000097N D20 SPHERE ESCAPE SP. THROUGH 20CM H20
    ESCAPE SPECTRUM FROM D20 SPHERE
    FISSION NEUTRONS UNIFORMLY DISTRIBUTED
    CALCULATED BY H.ING
    TRANSMITTED THROUGH H20 IS CALCULATED BY RPF1 CODE
    01.09.1973.


IDENTIFICATION NUMBER      0000098M
    0000098M SP.NO97 PENETR.1CM AL,REFL.FROM 20CM H20+SOURCE
    TRANSMITTED SPECTRUM THROUGH AL IS CALCULATED
    ASSUMING EXPONENTIAL ATTENUATION
    REFLECTED FROM H20 IS CALCULATED BY RPF1 CODE
    01.09.1973.
    SP.NO97 IS BY H.ING


IDENTIFICATION NUMBER      0000098N
    0000098N SP.NO.97 PENETR.1CM AL,THROUGH 20 CM H20
    TRANSMITTED SPECTRUM THROUGH AL IS CALCULATED
    ASSUMING EXPONENTIAL ATTENUATION
    TRANSMITTED THROUGH H20 IS CALCULATED
    BY RPF1 CODE,SP.NO 97 BY H.ING
    01.09.1973.
ENDEND
```

APPENDIX 7
TO OPERATION NAMED LIST

APPENDIX 8
TO OPERATION NAMED O5RK

PROOBA
06.07.1973.
SAMPLE FOR O5RK PROGRAM
ARBITRARY DATA
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**

	ENERGY EV	E*PHI(E)
1	2.17010E-01	3.34772E-03
2	3.53560E-01	2.09462E-03
3	7.07150E-01	3.40376E-03
4	1.46630E 00	3.79001E-03
5	3.16190E 00	4.02688E-03
6	6.81910E 00	5.92188E-03
7	1.46630E 01	7.20101E-03
8	3.16190E 01	7.86426E-03
9	6.81910E 01	8.62226E-03
10	1.46630E 02	8.76439E-03
11	3.16190E 02	6.63251E-03
12	6.81910E 02	4.59538E-03
13	1.46630E 03	6.01663E-03
14.	3.16190E 03	4.26376E-03
15	6.81910E 03	3.07938E-03
16	1.12200E 04	7.41564E-03
17	1.41250E 04	2.36669E-03
18	1.78160E 04	2.36669E-03
19	2.23850E 04	3.62893E-03
20	2.81820E 04	6.46896E-03
21	3.54780E 04	8.67788E-03
22	4.46630E 04	1.54624E-02
23	5.62260E 04	2.20891E-02
24	7.07820E 04	2.80848E-02
25	8.91170E 04	3.62893E-02
26	1.12200E 05	5.04895E-02
27	1.41250E 05	6.31118E-02
28	1.78160E 05	8.04676E-02
29	2.23850E 05	1.19912E-01
30	2.81820E 05	1.15179E-01
31	3.54780E 05	1.05712E-01
32	4.46630E 05	5.04895E-02
33	5.62260E 05	1.10446E-02
34	7.07820E 05	2.52447E-02
35	8.91170E 05	4.10227E-02
36	1.12200E 06	1.73558E-02
37	1.41250E 06	8.67788E-03
38	1.78160E 06	2.05113E-02
39	2.23850E 06	2.20891E-02
40	2.81820E 06	2.60336E-02
41	3.54780E 06	1.73558E-02
42	4.46630E 06	5.52228E-03
43	5.62260E 06	4.26005E-03
44	7.07820E 06	1.73558E-03
45	8.91170E 06	1.10446E-03
46	1.12200E 07	1.57780E-04
47	1.41250E 07	1.57780E-05
48	1.78160E 07	3.15559E-05

SPECTRUM INTERPOLATION FROM THE FOLLOWING TWO SPECTRA

IDENTIFICATION NUMBER 00000063
00000063 FISSION AL 2.5CM REFLECTED MUSPALB
CALCULATED BY MUSPALB CODE 06-1969
ABAGIAN SYSTEM
30-01-1973
***
**

INPUT SPECTRUM

	ENERGY EV	FLUX IS GIVEN IN ABAGIAN SYSTEM
1	3.40000E-01	6.46300E-29
2	7.33000E-01	4.21400E-27
3	1.58000E 00	2.74400E-25
4	3.40000E 00	1.78500E-23
5	7.33000E 00	1.16000E-21
6	1.58000E 01	7.54800E-20
7	3.40000E 01	4.90800E-18
8	7.33000E 01	3.19400E-16
9	1.58000E 02	2.07800E-14
10	3.40000E 02	1.35200E-12
11	7.33000E 02	8.80800E-11
12	1.58000E 03	5.74100E-09
13	3.40000E 03	3.74200E-07
14	7.33000E 03	1.20800E-05
15	1.58000E 04	3.54400E-04
16	3.40000E 04	1.68000E-03
17	7.33000E 04	4.77600E-03
18	1.50000E 05	1.20974E-02
19	3.00000E 05	2.55341E-02
20	6.00000E 05	5.29654E-02
21	1.10000E 06	6.75230E-02
22	1.95000E 06	5.95926E-02
23	3.25000E 06	3.00269E-02
24	5.25000E 06	6.90201E-03
25	8.50000E 06	5.50493E-04

APPENDIX 9/a
TO OPERATION NAMED FTAPE

OUTPUT SPECTRUM

E*PHI(E) SPECTRUM IS NORMALIZED TO UNIT AREA

	ENERGY EV	E*PHI(E)
1	2.17010E-01	0.00000E-01
2	3.53560E-01	3.08662E-28
3	7.07150E-01	5.85402E-27
4	1.46630E 00	3.53717E-25
5	3.16190E 00	2.30988E-23
6	6.81910E 00	1.50250E-21
7	1.46630E 01	9.72980E-20
8	3.16190E 01	6.35121E-18
9	6.81910E 01	4.13705E-16
10	1.46630E 02	2.67866E-14
11	3.16190E 02	1.74956E-12
12	6.81910E 02	1.14086E-10
13	1.46630E 03	7.40045E-09
14	3.16190E 03	4.84232E-07
15	6.81910E 03	1.68462E-05
16	1.12200E 04	2.52194E-04
17	1.41250E 04	4.26131E-04
18	1.78160E 04	7.44530E-04
19	2.23850E 04	1.23884E-03
20	2.81820E 04	1.86601E-03
21	3.54780E 04	2.66840E-03
22	4.46630E 04	3.74320E-03
23	5.62260E 04	5.09627E-03
24	7.07820E 04	6.79957E-03
25	8.91170E 04	9.53689E-03
26	1.12200E 05	1.26098E-02
27	1.41250E 05	1.67288E-02
28	1.78160E 05	2.17163E-02
29	2.23850E 05	2.77957E-02
30	2.81820E 05	3.55091E-02
31	3.54780E 05	4.53683E-02
32	4.46630E 05	5.78434E-02
33	5.62260E 05	7.35483E-02
34	7.07820E 05	8.33371E-02
35	8.91170E 05	9.12665E-02
36	1.12200E 06	9.90030E-02
37	1.41250E 06	9.59671E-02
38	1.78160E 06	9.08520E-02
39	2.23850E 06	7.87721E-02
40	2.81820E 06	5.91887E-02
41	3.54780E 06	3.94870E-02
42	4.46630E 06	2.37120E-02
43	5.62260E 06	9.17055E-03
44	7.07820E 06	4.94506E-03
45	8.91170E 06	0.00000E-01
46	1.12200E 07	0.00000E-01
47	1.41250E 07	0.00000E-01
48	1.78160E 07	0.00000E-01

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 8.74317E-[illegible]

THERMAL FLUX PER UNIT LETHARGY: 4.[illegible]2400E-31

INPUT SPECTRUM

	ENERGY EV	FLUX IS GIVEN IN ARAGIAN SYSTEM
1	3.40000E-01	1.97000E-24
2	7.33000E-01	6.30600E-23
3	1.58000E 00	2.01200E-21
4	3.40000E 00	6.30100E-20
5	7.33000E 00	2.02600E-18
6	1.58000E 01	6.42400E-17
7	3.40000E 01	2.03300E-15
8	7.33000E 01	6.42300E-14
9	1.58000E 02	2.03300E-12
10	3.40000E 02	6.42300E-11
11	7.33000E 02	2.03000E-09
12	1.58000E 03	6.41900E-08
13	3.40000E 03	2.04300E-06
14	7.33000E 03	3.30900E-05
15	1.58000E 04	8.44300E-04
16	3.40000E 04	2.65800E-03
17	7.33000E 04	8.05200E-03
18	1.50000E 05	1.95412E-02
19	3.00000E 05	4.34334E-02
20	6.00000E 05	8.73493E-02
21	1.10000E 06	1.12903E-01
22	1.95000E 06	9.56508E-02
23	3.25000E 06	4.70596E-02
24	5.25000E 06	1.10965E-02
25	8.50000E 06	8.80115E-04

IDENTIFICATION NUMBER 00000065

00000065 FISSION AL 5.0CM REFLECTED MUSPALB

CALCULATED BY MUSPALB CODE 06-1969

ARAGIAN SYSTEM

30-01-1973

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APPENDIX 9/b
TO OPERATION NAMED FTAPE

OUTPUT SPECTRUM

E*PHI(E) SPECTRUM IS NORMALIZED TO UNIT AREA

	ENERGY EV	E*PHI(E)
1	2.17010E-01	0.00000E-01
2	3.53560E-01	3.68342E-24
3	7.07150E-01	5.33311E-23
4	1.46630E 00	1.05161E-22
5	3.16190E 00	5.03145E-21
6	6.81910E 00	1.63707E-19
7	1.46630E 01	5.04828E-17
8	3.16190E 01	1.60371E-15
9	6.81910E 01	5.07140E-14
10	1.46630E 02	1.59764E-12
11	3.16190E 02	5.06677E-11
12	6.81910E 02	1.60282E-09
13	1.46630E 03	5.04442E-08
14	3.16190E 03	1.61156E-06
15	6.81910E 03	2.62437E-05
16	1.12200E 04	3.58120E-04
17	1.41250E 04	6.03238E-04
18	1.78160E 04	9.28043E-04
19	2.23850E 04	1.34386E-03
20	2.81820E 04	1.87143E-03
21	3.54780E 04	2.58415E-03
22	4.46630E 04	3.72287E-03
23	5.62260E 04	5.15641E-03
24	7.07820E 04	6.96102E-03
25	8.91170E 04	9.41331E-03
26	1.12200E 05	1.25366E-02
27	1.41250E 05	1.64672E-02
28	1.78160E 05	2.16518E-02
29	2.23850E 05	2.81429E-02
30	2.81820E 05	3.63786E-02
31	3.54780E 05	4.62543E-02
32	4.46630E 05	5.84824E-02
33	5.62260E 05	7.38763E-02
34	7.07820E 05	8.38781E-02
35	8.91170E 05	9.23423E-02
36	1.12200E 06	1.01579E-01
37	1.41250E 06	9.62535E-02
38	1.78160E 06	8.94866E-02
39	2.23850E 06	7.68391E-02
40	2.81820E 06	5.76295E-02
41	3.54780E 06	3.83628E-02
42	4.46630E 06	2.30709E-02
43	5.62260E 06	8.96521E-03
44	7.07820E 06	4.83211E-03
45	8.91170E 06	0.00000E-01
46	1.12200E 07	0.00000E-01
47	1.41250E 07	0.00000E-01
48	1.78160E 07	0.00000E-01

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 1.4[illegible]

THERMAL FLUX PER UNIT LETHARGY: 2.85200E-26

DATA OF THE INTERPOLATED SPECTRUM

IDENTIFICATION NUMBER 0000063A

THICKNESS (CM) 3.5

CALCULATED DATA

NUMBER OF THE STANDARD ENERGY GROUPS: 48

	STANDARD ENERGY EV	LIMITS OF THE ENERGY GROUPS E EV	E EV	LETHARGY INTERVALS	PHI(E)	E*PHI(E)
1	0.21701E 00	0.18845E 00	0.25000E 00	0.2710	0.00000E 00	0.00000E 00
2	0.35356E 00	0.25000E 00	0.50000E 00	0.6930	0.39793E-25	0.14069E-25
3	0.70715E 00	0.50000E 00	0.10000E 01	0.6930	0.33971E-24	0.23952E-24
4	0.14663E 01	0.10000E 01	0.21500E 01	0.7660	0.25107E-23	0.36814E-23
5	0.31619E 01	0.21500E 01	0.46500E 01	0.7660	0.67137E-22	0.21228E-21
6	0.68191E 01	0.46500E 01	0.10000E 02	0.7660	0.15348E-20	0.10446E-19
7	0.14663E 02	0.10000E 02	0.21500E 02	0.7660	0.86293E-19	0.12653E-17
8	0.31619E 02	0.21500E 02	0.46500E 02	0.7660	0.19584E-17	0.61921E-16
9	0.68191E 02	0.46500E 02	0.10000E 03	0.7660	0.44301E-16	0.30209E-14
10	0.14663E 03	0.10000E 03	0.21500E 03	0.7660	0.99999E-15	0.14663E-12
11	0.31619E 03	0.21500E 03	0.46500E 03	0.7660	0.22687E-13	0.71734E-11
12	0.68191E 03	0.46500E 03	0.10000E 04	0.7660	0.51362E-12	0.35024E-09
13	0.14663E 04	0.10000E 04	0.21500E 04	0.7660	0.11602E-10	0.17012E-07
14	0.31619E 04	0.21500E 04	0.46500E 04	0.7660	0.26428E-09	0.83562E-06
15	0.68191E 04	0.46500E 04	0.10000E 05	0.7660	0.31467E-08	0.21458E-04
16	0.11220E 05	0.10000E 05	0.12589E 05	0.2300	0.27589E-07	0.30953E-03
17	0.14125E 05	0.12589E 05	0.15848E 05	0.2300	0.36984E-07	0.52239E-03
18	0.17816E 05	0.15848E 05	0.19951E 05	0.2300	0.43688E-07	0.56743E-03
19	0.22375E 05	0.19951E 05	0.25117E 05	0.2300	0.60992E-07	0.13653E-02
20	0.28182E 05	0.25117E 05	0.31620E 05	0.2300	0.70717E-07	0.19929E-02
21	0.35478E 05	0.31620E 05	0.39805E 05	0.2300	0.79213E-07	0.28103E-02
22	0.44663E 05	0.39805E 05	0.50112E 05	0.2300	0.89213E-07	0.39845E-02
23	0.56226E 05	0.50112E 05	0.63086E 05	0.2300	0.97147E-07	0.54622E-02
24	0.70782E 05	0.63086E 05	0.79418E 05	0.2300	0.10345E-06	0.73221E-02
25	0.89117E 05	0.79418E 05	0.10000E 06	0.2300	0.11213E-06	0.99930E-02
26	0.11220E 06	0.10000E 06	0.12589E 06	0.2300	0.11961E-06	0.13421E-01
27	0.14125E 06	0.12589E 06	0.15848E 06	0.2300	0.12555E-06	0.17734E-01
28	0.17816E 06	0.15848E 06	0.19951E 06	0.2300	0.12988E-06	0.23139E-01
29	0.22375E 06	0.19951E 06	0.25117E 06	0.2300	0.13312E-06	0.29800E-01
30	0.28182E 06	0.25117E 06	0.31620E 06	0.2300	0.13572E-06	0.38249E-01
31	0.35478E 06	0.31620E 06	0.39806E 06	0.2300	0.13748E-06	0.48774E-01
32	0.44663E 06	0.39806E 06	0.50112E 06	0.2300	0.13877E-06	0.61975E-01
33	0.56226E 06	0.50112E 06	0.63086E 06	0.2300	0.13979E-06	0.78603E-01
34	0.70782E 06	0.63086E 06	0.79418E 06	0.2300	0.12593E-06	0.89133E-01
35	0.89117E 06	0.79418E 06	0.10000E 07	0.2300	0.10976E-06	0.97819E-01
36	0.11220E 07	0.10000E 07	0.12580E 07	0.2300	0.95473E-07	0.10734E 00
37	0.14125E 07	0.12589E 07	0.15842E 07	0.2300	0.72565E-07	0.10250E 00
38	0.17816E 07	0.15848E 07	0.19951E 07	0.2300	0.54072E-07	0.96334E-01
39	0.22375E 07	0.19951E 07	0.25117E 07	0.2300	0.37169E-07	0.83202E-01
40	0.28182E 07	0.25117E 07	0.31620E 07	0.2300	0.22167E-07	0.62471E-01
41	0.35478E 07	0.31620E 07	0.39806E 07	0.2300	0.11737E-07	0.41640E-01
42	0.44663E 07	0.39806E 07	0.50112E 07	0.2300	0.56019E-08	0.25020E-01
43	0.56226E 07	0.50112E 07	0.63086E 07	0.2300	0.17243E-08	0.96943E-02
44	0.70782E 07	0.63086E 07	0.79418E 07	0.2300	0.73843E-09	0.52268E-02
45	0.89117E 07	0.79418E 07	0.10000E 08	0.2300	0.00000E 00	0.00000E 00
46	0.11220E 08	0.10000E 08	0.12580E 08	0.2300	0.00000E 00	0.00000E 00
47	0.14125E 08	0.12589E 08	0.15848E 08	0.2300	0.00000E 00	0.00000E 00
48	0.17816E 08	0.15848E 08	0.19951E 08	0.2300	0.00000E 00	0.00000E 00

THERMAL FLUX PER UNIT LETHARGY: 3.81128E-29

APPENDIX 9/c

TO OPERATION NAMED FTAPE

SPECTRA NORMALIZED TO UNIT AREA

	E*PHI(E)	E*KERMA(E)	E*REM-DOSE(E)
1	0.00000E 00	0.00000E 00	0.00000E 00
2	0.13109E-25	0.31706E-28	0.46243E-27
3	0.22454E-24	0.38068E-27	0.79690E-26
4	0.34511E-23	0.40807E-26	0.12829E-24
5	0.19910E-21	0.16264E-24	0.75623E-23
6	0.98136E-20	0.55022E-23	0.38127E-21
7	0.11862E-17	0.51048E-21	0.48091E-19
8	0.58048E-16	0.22711E-19	0.23783E-17
9	0.28320E-14	0.13419E-17	0.11959E-15
10	0.13746E-12	0.10457E-15	0.56908E-14
11	0.67247E-11	0.96470E-14	0.26976E-12
12	0.32833E-09	0.95630E-12	0.13040E-10
13	0.15948E-07	0.10191E-09	0.60604E-09
14	0.78334E-06	0.10761E-07	0.29121E-07
15	0.20116E-04	0.58589E-06	0.74780E-06
16	0.29018E-03	0.14129E-04	0.14093E-04
17	0.48972E-03	0.29804E-04	0.28132E-04
18	0.81317E-03	0.60094E-04	0.56325E-04
19	0.12709E-02	0.11684E-03	0.10378E-03
20	0.18683E-02	0.20304E-03	0.18307E-03
21	0.26345E-02	0.34931E-03	0.30269E-03
22	0.37352E-02	0.59268E-03	0.51437E-03
23	0.51205E-02	0.95717E-03	0.84342E-03
24	0.68600E-02	0.15516E-02	0.13393E-02
25	0.93679E-02	0.24841E-02	0.21999E-02
26	0.12501E-01	0.38831E-02	0.35070E-02
27	0.16624E-01	0.59261E-02	0.55896E-02
28	0.21602E-01	0.89582E-02	0.85753E-02
29	0.27935E-01	0.13437E-01	0.12977E-01
30	0.35856E-01	0.19172E-01	0.20291E-01
31	0.45723E-01	0.27827E-01	0.29935E-01
32	0.58111E-01	0.40150E-01	0.45155E-01
33	0.73633E-01	0.57336E-01	0.65975E-01
34	0.83557E-01	0.72647E-01	0.79063E-01
35	0.91700E-01	0.87700E-01	0.10224E 00
36	0.10013E 00	0.10411E 00	0.11901E 00
37	0.96086E-01	0.10443E 00	0.11769E 00
38	0.90308E-01	0.11385E 00	0.11291E 00
39	0.77997E-01	0.10511E 00	0.98833E-01
40	0.58563E-01	0.86558E-01	0.74709E-01
41	0.39035E-01	0.71271E-01	0.49798E-01
42	0.23455E-01	0.42824E-01	0.30115E-01
43	0.90813E-02	0.17779E-01	0.11708E-01
44	0.48958E-02	0.10863E-01	0.63332E-02
45	0.00000E 00	0.00000E 00	0.00000E 00
46	0.00000E 00	0.00000E 00	0.00000E 00
47	0.00000E 00	0.00000E 00	0.00000E 00
48	0.00000E 00	0.00000E 00	0.00000E 00

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 1.06673E 00
FACTOR TO E*KER(E) 2.45385E-09
FACTOR TO E*REM(E) 3.48356E-08

THERMAL NEUTRON KERMA: 6.73488E-40
THERMAL NEUTRON DOSE: 8.14375E-38

	KERMA(E)	REM-DOSE(E)
1	0.00000E 00	0.00000E 00
2	0.22005E-36	0.45563E-34
3	0.13210E-35	0.39257E-33
4	0.68290E-35	0.30479E-32
5	0.12622E-33	0.83317E-31
6	0.19800E-32	0.19477E-29
7	0.85430E-31	0.11425E-27
8	0.17625E-29	0.26203E-26
9	0.48238E-28	0.61091E-25
10	0.17500E-26	0.13520E-23
11	0.74867E-25	0.29720E-22
12	0.34413E-23	0.66617E-21
13	0.17055E-21	0.14398E-19
14	0.83511E-20	0.32083E-18
15	0.21033E-18	0.38201E-17
16	0.30900E-17	0.43756E-16
17	0.51777E-17	0.69381E-16
18	0.82770E-17	0.11013E-15
19	0.12808E-16	0.16151E-15
20	0.17679E-16	0.22629E-15
21	0.24160E-16	0.29721E-15
22	0.32543E-16	0.40119E-15
23	0.41773E-16	0.52255E-15
24	0.53792E-16	0.65915E-15
25	0.68481E-16	0.85995E-15
26	0.84926E-16	0.10888E-14
27	0.10295E-15	0.13785E-14
28	0.12338E-15	0.16767E-14
29	0.14510E-15	0.20195E-14
30	0.16694E-15	0.25081E-14
31	0.19247E-15	0.29393E-14
32	0.22064E-15	0.35219E-14
33	0.25023E-15	0.40875E-14
34	0.25185E-15	0.38911E-14
35	0.24148E-15	0.39965E-14
36	0.22770E-15	0.36949E-14
37	0.18141E-15	0.29026E-14
38	0.15681E-15	0.22077E-14
39	0.11522E-15	0.15380E-14
40	0.75368E-16	0.92348E-15
41	0.49295E-16	0.48896E-15
42	0.23528E-16	0.23489E-15
43	0.77591E-17	0.72539E-16
44	0.37660E-17	0.31169E-16
45	0.00000E 00	0.00000E 00
46	0.00000E 00	0.00000E 00
47	0.00000E 00	0.00000E 00
48	0.00000E 00	0.00000E 00

APPENDIX 9/d
TO OPERATION NAMED FTAPE

DOSE FRACTIONS

	WITHOUT THERMAL NEUTRON DOSE	WITH THERMAL NEUTRON DOSE
LESS THAN 0.5EV	0.00000	0.00000
0.5EV-1.0EV	0.00000	0.00000
1.0EV-1.0KEV	0.00000	0.00000
1.0KEV-10.0KEV	0.00000	0.00000
10.0KEV-0.1MEV	0.00559	0.00559
0.1MEV-0.5MEV	0.12603	0.12603
0.5MEV-0.794MEV	0.14504	0.14504
0.794MEV-1.0MEV	0.10224	0.10224
1.0MEV-1.58MEV	0.23670	0.23670
1.58MEV-2.51MEV	0.21174	0.21174
2.51MEV-5.8MEV	0.17266	0.17266
SUM OF DOSE	8.01220E-09	8.01220E-09

AVERAGE ENERGY(EV): 1.32861E 06

FLUX FRACTIONS

	WITH THERMAL NEUTRON FLUX
LESS THAN 0.5EV	0.00000
0.5EV-1.0EV	0.00000
1.0EV-1.0KEV	0.00000
1.0KEV-10.0KEV	0.00007
10.0KEV-0.1MEV	0.03246
0.1MEV-0.5MEV	0.21850
0.5MEV-0.794MEV	0.15723
0.794MEV-1.0MEV	0.09170
1.0MEV-1.58MEV	0.19671
1.58MEV-2.51MEV	0.16830
2.51MEV-5.8MEV	0.13503
SUM OF FLUX	2.45360E-01

	NORMALIZED PHI(U)*DU SPECTRUM WITH THERMAL NEUTRONS	NORMALIZED REM-DOSE(U)*DU SPECTRUM
1	0.00000E-01	0.00000E-01
2	3.97372E-26	1.39333E-27
3	6.76505E-25	2.40108E-26
4	1.14931E-23	4.27274E-25
5	6.62725E-22	2.51858E-23
6	3.26752E-20	1.26979E-21
7	3.95022E-18	1.60163E-19
8	1.93315E-16	7.92089E-18
9	9.43120E-15	3.98275E-16
10	4.57767E-13	1.89528E-14
11	2.23950E-11	8.98409E-13
12	1.09344E-09	4.34297E-11
13	5.31106E-08	2.01839E-09
14	2.60875E-06	9.69846E-08
15	6.69904E-05	2.49048E-06
16	2.90171E-04	1.40932E-05
17	4.89691E-04	2.81324E-05
18	8.13125E-04	5.63251E-05
19	1.27933E-03	1.03782E-04
20	1.86818E-03	1.83071E-04
21	2.63438E-03	3.02687E-04
22	3.73507E-03	5.14367E-04
23	5.12026E-03	8.43422E-04
24	6.86371E-03	1.33933E-03
25	9.36740E-03	2.19993E-03
26	1.25835E-02	3.50698E-03
27	1.66237E-02	5.58960E-03
28	2.16905E-02	8.57527E-03
29	2.79341E-02	1.29769E-02
30	3.58544E-02	2.02907E-02
31	4.57207E-02	2.99345E-02
32	5.80983E-02	4.51551E-02
33	7.36795E-02	6.59744E-02
34	8.35533E-02	7.90630E-02
35	9.16955E-02	1.02240E-01
36	1.00625E-01	1.19006E-01
37	9.60878E-02	1.17694E-01
38	9.03035E-02	1.12911E-01
39	7.79933E-02	9.88324E-02
40	5.85601E-02	7.47090E-02
41	3.90335E-02	4.97976E-02
42	2.34535E-02	3.01151E-02
43	9.08788E-03	1.17081E-02
44	4.89958E-03	6.33324E-03
45	0.00000E-01	0.00000E-01
46	0.00000E-01	0.00000E-01
47	0.00000E-01	0.00000E-01
48	0.00000E-01	0.00000E-01

NORMALIZED THERMAL FLUX: 3.31911E-28

NORMALIZED THERMAL DOSE: 1.01642E-29

APPENDIX 9/e
TO OPERATION NAMED FTAPE

APPENDIX 10
TO OPERATION NAMED DOSEVA (1)

RESPONSE OF A DOSIMETER

INPUT RESPONSE

1MODI000 RESPONSE OF THE ALBEDO DOSIMETER
BY HARVEY-HUDD-TOWNSEND
DISTANCE FROM THE BODY IS 2 CM
NUMBER OF THE INPUT POINTS IS 25 + THERMAL DATA
DATA WERE READ FROM THE CURVE
DATA ARE GIVEN IN RELATIVE UNITS

	ENERGY EV	RESPONSE
1	3.400E-01	1.850E 01
2	7.330E-01	2.010E 01
3	1.580E 00	2.180E 01
4	3.400E 00	2.270E 01
5	7.330E 00	2.290E 01
6	1.580E 01	2.250E 01
7	3.400E 01	2.120E 01
8	7.330E 01	1.980E 01
9	1.580E 02	1.840E 01
10	3.400E 02	1.760E 01
11	7.330E 02	1.760E 01
12	1.580E 03	1.730E 01
13	3.400E 03	1.700E 01
14	7.330E 03	1.550E 01
15	1.580E 04	9.900E 00
16	3.400E 04	5.100E 00
17	7.330E 04	2.000E 00
18	1.500E 05	1.000E 00
19	3.000E 05	7.000E-01
20	6.000E 05	6.000E-01
21	1.100E 06	4.000E-01
22	1.950E 06	3.500E-01
23	3.250E 06	2.800E-01
24	5.250E 06	2.100E-01
25	8.500E 06	1.400E-01

TRANSFORMATED RESPONSE

	ENERGY EV	RESPONSE
1	2.17010E-01	0,00000E-01
2	3.53560E-01	1,85443E 01
3	7.07150E-01	1,99948E 01
4	1.46630E 00	2,15718E 01
5	3.16190E 00	2,25823E 01
6	6.81910E 00	2,28740E 01
7	1.46630E 01	2,25537E 01
8	3.16190E 01	2.13701E 01
9	6.81910E 01	1,99820E 01
10	1.46630E 02	1,85879E 01
11	3.16190E 02	1,77047E 01
12	6.81910E 02	1,76000E 01
13	1.46630E 03	1,73403E 01
14	3.16190E 03	1,70392E 01
15	6.81910E 03	1,56950E 01
16	1.12200E 04	1,29281E 01
17	1.41250E 04	1,10074E 01
18	1.78160E 04	9,36831E 00
19	2.23850E 04	8,16330E 00
20	2.81820E 04	6,63442E 00
21	3.54780E 04	4,98341E 00
22	4.46630E 04	4,25890E 00
23	5.62260E 04	3.34680E 00
24	7.07820E 04	2,19862E 00
25	8.91170E 04	1,79378E 00
26	1.12200E 05	1.49283E 00
27	1.41250E 05	1,11408E 00
28	1.78160E 05	9,43680E-01
29	2.23850E 05	8.52300E-01
30	2.81820E 05	7,36360E-01
31	3.54780E 05	6.81740E-01
32	4.46630E 05	6.51123E-01
33	5.62260E 05	6.12580E-01
34	7.07820E 05	5.56872E-01
35	8.91170E 05	4.83532E-01
36	1.12200E 06	3.98706E-01
37	1.41250E 06	3.81618E-01
38	1.78160E 06	3.59906E-01
39	2.23850E 06	3.34465E-01
40	2.81820E 06	3.03251E-01
41	3.54780E 06	2.69577E-01
42	4.46630E 06	2.37430E-01
43	5.62260E 06	2,01975E-01
44	7.07820E 06	1.70623E-01
45	8.91170E 06	0.00000E-01
46	1.12200E 07	0,00000E-01
47	1.41250E 07	0,00000E-01
48	1.78160E 07	0,00000E-01

THERMAL RESPONSE 1.95000E 01

RESPONSE-FUNCTION INTERPOLATION IS TERMINATED

INPUT RESPONSE

	ENERGY EV	RESPONSE
1	3.40000E-01	1.85000E 01
2	7.33000E-01	2.01000E 01
3	1.58000E 00	2.18000E 01
4	3.40000E 00	2.27000E 01
5	7.33000E 00	2.29000E 01
6	1.58000E 01	2.25000E 01
7	3.40000E 01	2.12000E 01
8	7.33000E 01	1.98000E 01
9	1.58000E 02	1.84000E 01
10	3.40000E 02	1.76000E 01
11	7.33000E 02	1.76000E 01
12	1.58000E 03	1.73000E 01
13	3.40000E 03	1.70000E 01
14	7.33000E 03	1.55000E 01
15	1.58000E 04	9.90000E 00
16	3.40000E 04	5.10000E 00
17	7.33000E 04	2.00000E 00
18	1.50000E 05	1.00000E 00
19	3.00000E 05	7.00000E-01
20	6.00000E 05	6.00000E-01
21	1.10000E 06	4.00000E-01
22	1.95000E 06	3.50000E-01
23	3.25000E 06	2.80000E-01
24	5.25000E 06	2.10000E-01
25	8.50000E 06	1.40000E-01

READING OF A DOSIMETER
USED SPECTRUM

IDENTIFICATION NUMBER 00000070
00000070 VINCA,HEAVY WATER MODERATED REACTOR SPECTRUM
INPUT.NEUTRON ESCAPING/CORE NEUTRON
ARRIVED IN 1960
USE FOR INTERCOMPARISON IN VINCA, 1973.
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USED RESPONSE

IDENTIFICATION NUMBER 1MODI000
1MODI000 RESPONSE OF THE ALBEDO DOSIMETER
BY HARVEY-HUDD-TOWNSEND
DISTANCE FROM THE BODY IS 2 CM
NUMBER OF THE INPUT POINTS IS 25 + THERMAL DATA
DATA WERE READ FROM THE CURVE
DATA ARE GIVEN IN RELATIVE UNITS

APPENDIX 11/a
TO OPERATION NAMED DOSEVA (2)

OUTPUT RESPONSE

	ENERGY EV	RESPONSE
1	2.17010E-01	0.00000E-01
2	3.53560E-01	1.85443E 01
3	7.07150E-01	1.99948E 01
4	1.46630E 00	2.15718E 01
5	3.16190E 00	2.25823E 01
6	6.81910E 00	2.28740E 01
7	1.46630E 01	2.25537E 01
8	3.16190E 01	2.13701E 01
9	6.81910E 01	1.99820E 01
10	1.46630E 02	1.85879E 01
11	3.16190E 02	1.77047E 01
12	6.81910E 02	1.76000E 01
13	1.46630E 03	1.73403E 01
14	3.16190E 03	1.70392E 01
15	6.81910E 03	1.56950E 01
16	1.12200E 04	1.29281E 01
17	1.41250E 04	1.10074E 01
18	1.78160E 04	9.36831E 00
19	2.23850E 04	8.16330E 00
20	2.81820E 04	6.63442E 00
21	3.54780E 04	4.98341E 00
22	4.46630E 04	4.25890E 00
23	5.62260E 04	3.34680E 00
24	7.07820E 04	2.19862E 00
25	8.91170E 04	1.79378E 00
26	1.12200E 05	1.49283E 00
27	1.41250E 05	1.11408E 00
28	1.78160E 05	9.43680E-01
29	2.23850E 05	8.52300E-01
30	2.81820E 05	7.36360E-01
31	3.54780E 05	6.81740E-01
32	4.46630E 05	6.51123E-01
33	5.62260E 05	6.12580E-01
34	7.07820E 05	5.56872E-01
35	8.91170E 05	4.83532E-01
36	1.12200E 06	3.98706E-01
37	1.41250E 06	3.81618E-01
38	1.78160E 06	3.59906E-01
39	2.23850E 06	3.34465E-01
40	2.81820E 06	3.03251E-01
41	3.54780E 06	2.69577E-01
42	4.46630E 06	2.37430E-01
43	5.62260E 06	2.01975E-01
44	7.07820E 06	1.70623E-01
45	8.91170E 06	0.00000E-01
46	1.12200E 07	0.00000E-01
47	1.41250E 07	0.00000E-01
48	1.78160E 07	0.00000E-01

THERMAL RESPONSE: 19.5000

SUM OF DOSE: 7.23615E-07

READING OF THE DOSIMETER: 2.69438E 00

SUM(RESP*DOSE)/SUM(DOSE)

INPUT SPECTRUM

	ENERGY EV	E*PHI(E) PER 1.00000 LETHARGY INTERVAL
1	1.00000E-01	2.80000E 00
2	1.60000E-01	3.35000E 00
3	2.00000E-01	3.60000E 00
4	3.00000E-01	3.90000E 00
5	5.00000E-01	4.35000E 00
6	8.00000E-01	4.65000E 00
7	1.00000E 00	4.75000E 00
8	1.40000E 00	4.85000E 00
9	2.00000E 00	4.90000E 00
10	3.00000E 00	4.90000E 00
11	4.00000E 00	4.95000E 00
12	6.00000E 00	5.00000E 00
13	8.00000E 00	5.05000E 00
14	1.00000E 01	5.10000E 00
15	1.60000E 01	5.15000E 00
16	2.00000E 01	5.20000E 00
17	4.00000E 01	5.40000E 00
18	1.00000E 02	5.50000E 00
19	2.00000E 02	5.60000E 00
20	5.00000E 02	5.75000E 00
21	1.00000E 03	5.85000E 00
22	2.00000E 03	5.90000E 00
23	5.00000E 03	5.97000E 00
24	7.00000E 03	6.00000E 00
25	1.00000E 04	6.03000E 00
26	2.00000E 04	6.08000E 00
27	4.00000E 04	6.10000E 00
28	6.00000E 04	6.10000E 00
29	8.00000E 04	6.12000E 00
30	1.00000E 05	6.15000E 00
31	1.40000E 05	6.18000E 00
32	2.00000E 05	6.00000E 00
33	2.50000E 05	5.85000E 00
34	3.00000E 05	5.90000E 00
35	4.00000E 05	6.02000E 00
36	5.00000E 05	6.20000E 00
37	6.00000E 05	6.00000E 00
38	7.00000E 05	5.25000E 00
39	8.00000E 05	5.15000E 00
40	9.00000E 05	5.35000E 00
41	1.00000E 06	5.55000E 00
42	1.50000E 06	5.65000E 00
43	2.00000E 06	5.55000E 00
44	4.00000E 06	2.05000E 00
45	6.00000E 06	9.80000E-01
46	9.00000E 06	9.10000E-01
47	1.00000E 07	9.00000E-01

OUTPUT SPECTRUM

E*PHI(E) SPECTRUM IS NORMALIZED TO UNIT AREA

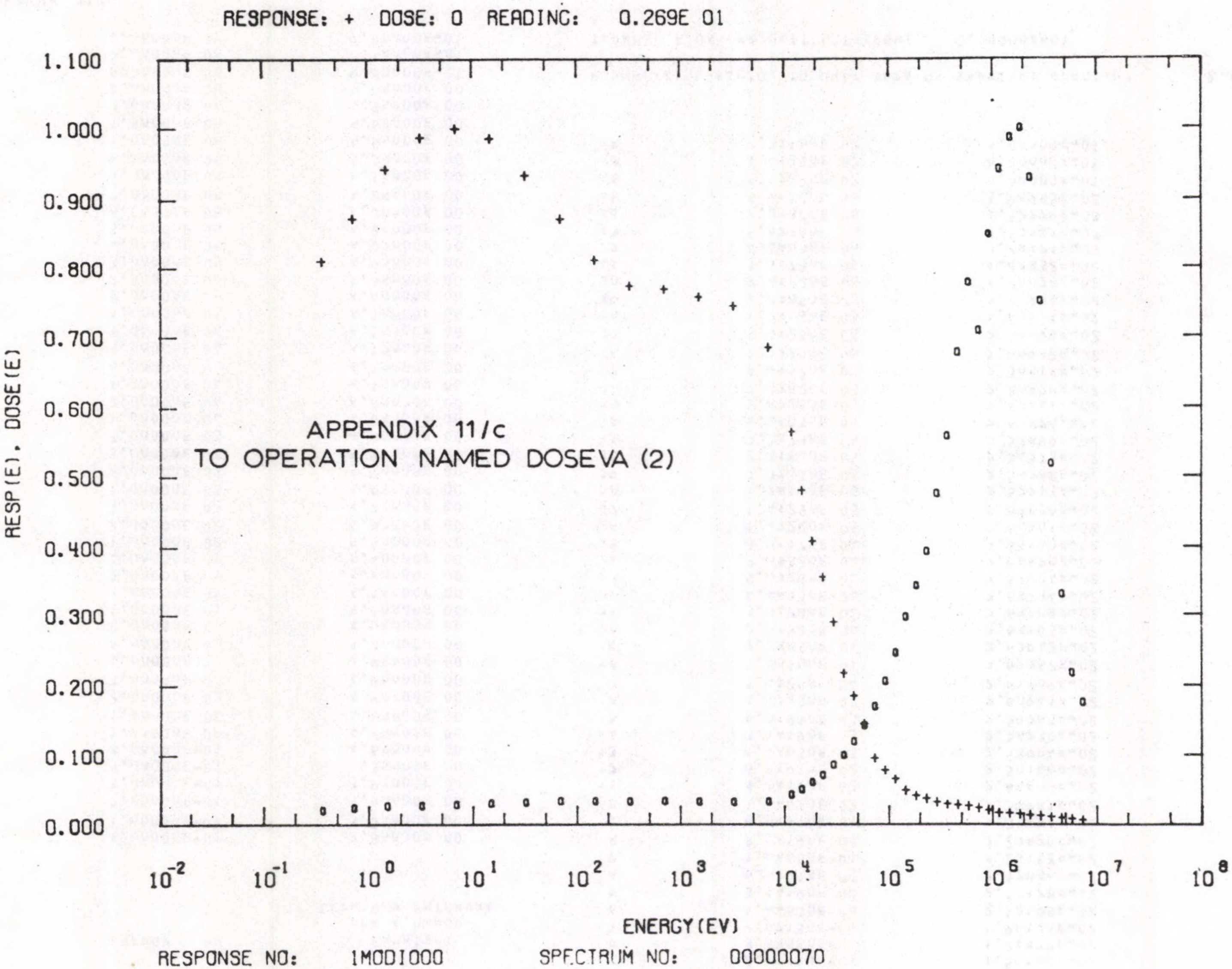
	ENERGY EV	E*PHI(E)
1	2.17010E-01	1.59100E-02
2	3.53560E-01	1.74577E-02
3	7.07150E-01	1.98126E-02
4	1.46630E 00	2.10095E-02
5	3.16190E 00	2.12178E-02
6	6.81910E 00	2.17036E-02
7	1.46630E 01	2.22153E-02
8	3.16190E 01	2.29820E-02
9	6.81910E 01	2.35474E-02
10	1.46630E 02	2.39781E-02
11	3.16190E 02	2.44600E-02
12	6.81910E 02	2.50146E-02
13	1.46630E 03	2.53904E-02
14	3.16190E 03	2.56230E-02
15	6.81910E 03	2.59263E-02
16	1.12200E 04	2.60941E-02
17	1.41250E 04	2.61569E-02
18	1.78160E 04	2.62367E-02
19	2.23850E 04	2.62942E-02
20	2.81820E 04	2.63193E-02
21	3.54780E 04	2.63508E-02
22	4.46630E 04	2.63704E-02
23	5.62260E 04	2.63704E-02
24	7.07820E 04	2.64170E-02
25	8.91170E 04	2.65160E-02
26	1.12200E 05	2.66261E-02
27	1.41250E 05	2.67000E-02
28	1.78160E 05	2.62213E-02
29	2.23850E 05	2.56288E-02
30	2.81820E 05	2.54272E-02
31	3.54780E 05	2.57899E-02
32	4.46630E 05	2.63874E-02
33	5.62260E 05	2.62444E-02
34	7.07820E 05	2.26620E-02
35	8.91170E 05	2.30518E-02
36	1.12200E 06	2.40982E-02
37	1.41250E 06	2.43494E-02
38	1.78160E 06	2.41815E-02
39	2.23850E 06	2.21884E-02
40	2.81820E 06	1.78028E-02
41	3.54780E 06	1.22832E-02
42	4.46630E 06	7.78371E-03
43	5.62260E 06	5.10941E-03
44	7.07820E 06	4.12779E-03
45	8.91170E 06	3.94285E-03
46	1.12200E 07	0.00000E-01
47	1.41250E 07	0.00000E-01
48	1.78160E 07	0.00000E-01

NORMALIZING FACTOR TO UNIT AREA OF E*PHI(E) SPECTRUM 2.31320E 02

THERMAL FLUX PER UNIT LETHARGY: 0.00000E-01

APPENDIX 11/b
TO OPERATION NAMED DOSEVA (2)

APPENDIX 11/c
TO OPERATION NAMED DOSEVA (2)



62.044

Kiadja a Központi Fizikai Kutató Intézet
Felelős kiadó: Szabó Ferenc igazgatóhelyettes
Szakmai lektor: Koblinger László
Hegedüs Csaba
Nyelvi lektor: Koblinger László
Példányszám: 405 Törzsszám: 73-9028
Készült a KFKI sokszorosító üzemében
Budapest, 1973. október hó